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ASTM

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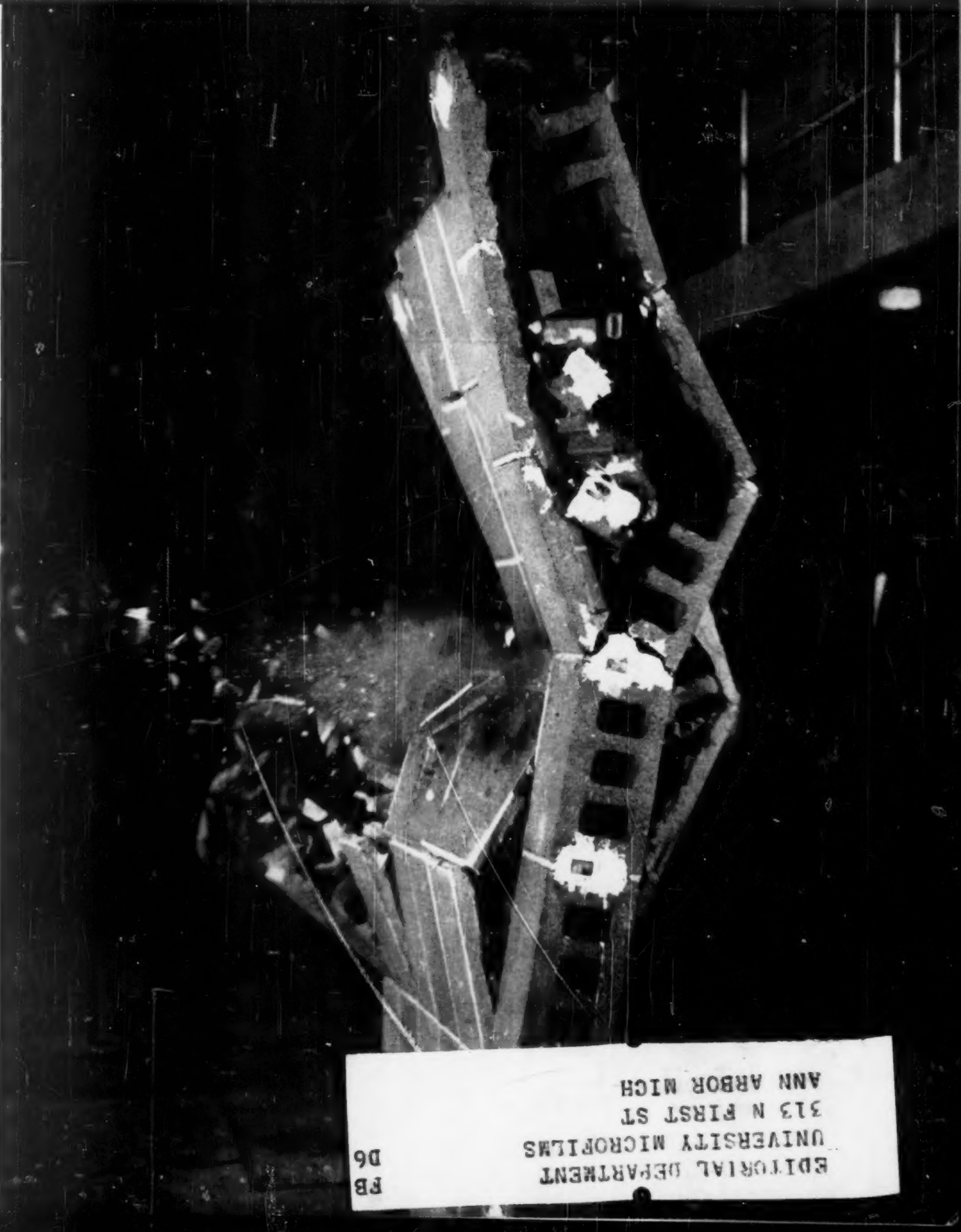

$$S = \frac{Ec}{2\sqrt{N}} + S_e$$

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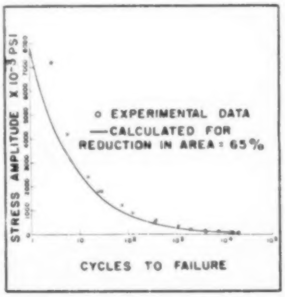
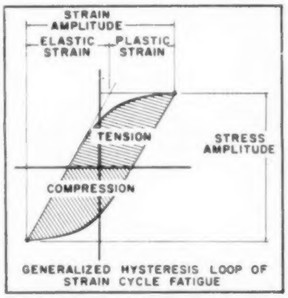


Typical curve (for 1018 carbon) shows correlation between Instron data (dots) and formula (solid lines).



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$$^{*}\boxed{S = \frac{Ec}{2\sqrt{N}} + S_e}$$

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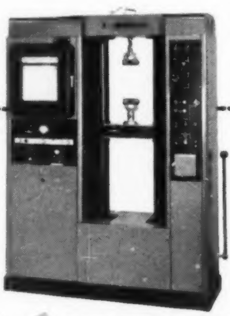

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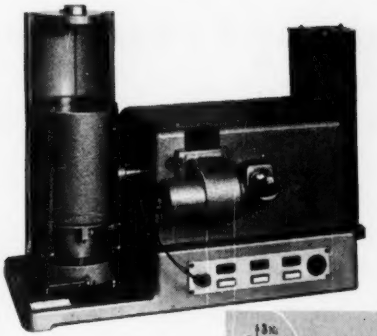
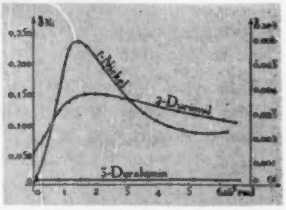


MI-9



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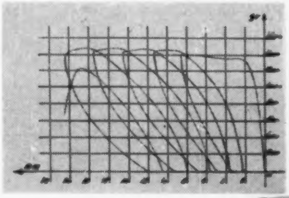

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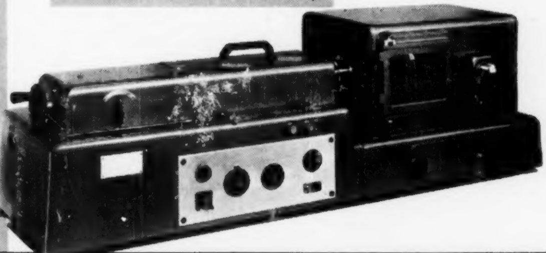

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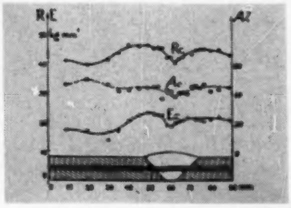

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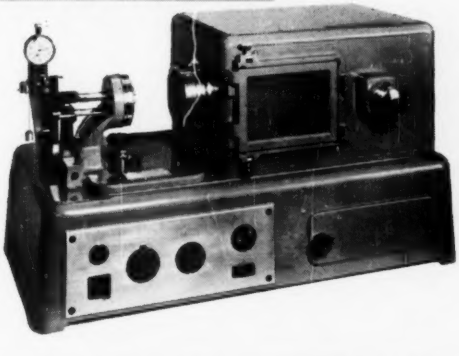

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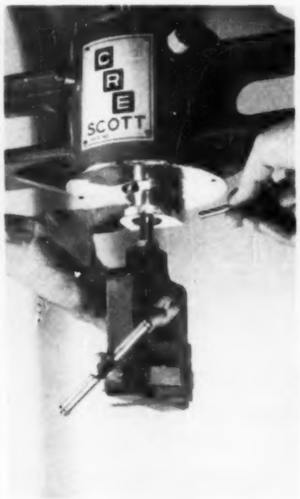

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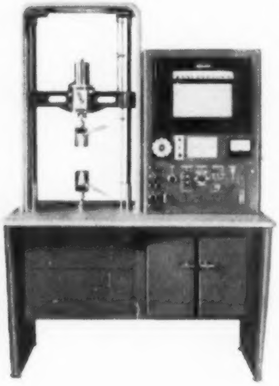

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Materials
Research & Standards

Volume 1, Number 1, January 1961

Workability of Masonry Mortars

By LEO KAMPF

WORKABILITY IS PERHAPS one of the most important properties of a masonry mortar. It determines the quality of the work and the cost of the masonry construction. If the mortar is not workable, then the mason will have difficulty making a tight joint. The result will be seepage, efflorescence, and a weakened structure. If the mortar is unworkable the mason will lay fewer bricks, and thereby increase the cost.

The measurement of workability is rather elusive, because it is made up of more than one property. The only available test uses the flow table (ASTM Tentative Specification for Flow Table for Use in Tests of Hydraulic Cement (C 230.)[1] This does not measure workability but rather consistency in a somewhat crude fashion.

Suppose a mortar were mixed with one part cement to six parts of sand, and enough water to give 100 per cent flow. Then if one part of hydrated lime were added to give a 1:1:6 mortar and enough water to give also a 100 per cent flow, the workability would be greatly improved even though it had the same flow. If, a finely ground limestone in lieu of lime, and an air-entraining agent were added, to entrain about 16 per cent of air (equivalent to a 1:3 masonry mortar) the workability would be further improved. If, instead of adding the finely ground limestone, the air were increased to about 25 per cent (by means of a special admixture[2]) the workability would be still further improved. Yet all four mortars would give the same flow.

A straight cement-sand mortar is granular and flows easily as the flow table is operated. A mortar that is plasticized with lime, limestone, or air is cohesive and does not flow readily under these conditions.

Workability of a masonry mortar is controlled by six properties: (1) consistency, (2) water retention, (3) time of set, (4) weight, (5) adhesion, and (6) penetrability.

Consistency:—This is ordinarily measured with the flow table. Although the flow test does not measure workability it can measure a wide range of consistency

Water Retention:—A mortar that has a low water retention will stiffen rapidly when applied to the brick. The mason will therefore have difficulty spreading such a mortar.

Time of Set:—A mortar that sets too fast will stiffen in the pan, especially in warm weather. This will reduce the workability of a mortar.

Weight:—The mason must lift the mortar from his pan to the brick. The quantity per brick is not large, but over a day it mounts up and will therefore affect the amount of brick laid. The following calculations will illustrate:

Assuming an 8-in. wall with a $\frac{1}{2}$-in. joint and standard $2\frac{1}{2}$ by $3\frac{3}{4}$ by 8 in. brick, a minimum of 15 cu ft of mortar will be used for each 1000 brick laid with no allowance for waste. Table I gives the weights of mortars.

TABLE I.—WEIGHTS OF MORTARS

Mortar	Type Mortar	Weight, per cu ft, lb	Weight per 1000 Brick, lb
1:1:6	Cement-lime	130	1950
1:3	Masonry Cement	120	1800
1:6	Cement plus 1 per cent admixture[a]	105	1575

[a] Special admixture known as X-Lime.

Adhesion:—To be workable a mortar must be adhesive to itself (cohesive), to the trowel, and to the brick to which it is applied. The adhesive force of four mortars was measured in a manner similar to the determination of the surface tension of liquids with the du Nouy tensiometer. A 12-gage nichrome wire was bent into a 1-in. circle with one end bent over as a hook. This was then attached to the pan hook of a triple beam balance by means of a cord. The mortar was mixed to a flow of 100 to 115 per cent and then placed in a Vicat mold. This was placed on an adjustable platform above the balance pan and raised till the ring was embedded to half the wire diameter in the mortar. The weight on the beam was adjusted until the ring was just pulled from the mortar.

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[1] 1958 Book of ASTM Standards, Part 4, p. 196.
[2] Special admixture known as X-Lime.

LEO KAMPF received his B.S. in chemistry and an M.S. in physics from New York University. He is in charge of the Laboratories of the Borough of Queens, City of New York, supervising the testing of materials used in the bulk of public construction in New York City. He has a patent on a masonry mortar and is at present working on factors contributing to the bond between mortar and brick.

TABLE II.—ADHESION TENSION.

Mix	Type Mortar	Water, per cent	Air, per cent	Flow, per cent	Adhesion Tension, g
1:6.	Cement	100	7	106	2.7
1:1:6. . .	Cement-lime	120	4	109	3.2
1:3.	Masonry cement	60	16	168	4.0
1:6.	Cement plus 1 per cent admixture	76	25	103	4.7

TABLE III.—PENETRABILITY.

Mix	Type	Flow, per cent	Penetration, 275 g, $\frac{3}{4}$ in. diam., 30 sec, mm
1:6. . . .	Cement	106	2
1:1:6. .	Cement-lime	112	15
1:3. . . .	Masonry cement	110	16
1:6. . . .	Cement plus 1 per cent admixture	105	28

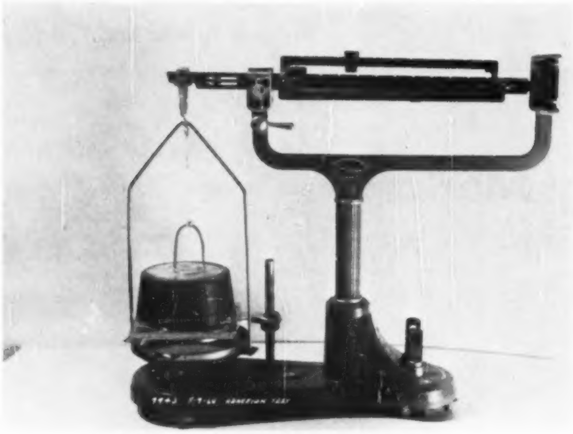

Fig. 1.—Apparatus for adhesion test.

TABLE IV.—RELATION BETWEEN AIR CONTENT, FLOW, AND PENETRATION.

Air Content, per cent	Per Cent Flow	Penetration, $\frac{3}{4}$ in., 175 g, 30 sec, mm
21.7.	111.9	9.5
24.8.	113.9	19.0
25.7.	114.0	23.0
28.9.	115.6	29.5

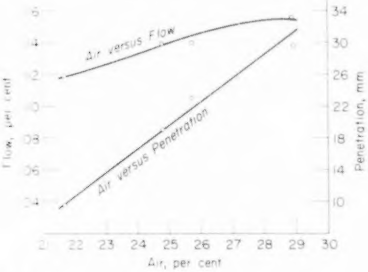

Fig. 3.—Relation between air, flow, and penetration.

The weight on the ring and cord was subtracted from this weight and recorded as the adhesion tension of the mortars. The apparatus is shown in Fig. 1. The results are shown in Table II.

Penetrability:—A portion of the mortar is lifted by the mason with his trowel, placed on the brick and then spread. If the trowel penetrates the mortar more readily it will spread more easily and will be considered a workable mortar.

To measure this property the Vicat apparatus was used according to ASTM Method of Test for Normal Consistency of Hydraulic Cement (C 187)[3] modified as follows: The shaft was replaced with a hollow tube. One end of this was threaded into an aluminum cylinder $\frac{3}{4}$ in. in diameter by $1\frac{3}{4}$ in. in length. The total weight of shaft, cylinder, and pointer was adjusted to 275 g, (Fig. 2). The penetration was then determined in the same manner as normal consistency or time of set. The mortars were made to a flow of 100 to 115 per cent. The greater the penetration the greater the workability. The results are shown in Table III.

It is quite obvious that increasing the air content increases workability whether it be mortar or concrete. To demonstrate the relation between workability, and the flow and penetration, the following experiment was made: Mortars were prepared in which the proportions and water were fixed (1:6 by volume and 80 per cent water). Various quantities of an air-entraining additive were added to vary the air content between 20 and 30 per cent. Flow, air content, and penetration ($\frac{3}{4}$ in., 175 g, 30 sec) were determined on each mortar. The results are shown in Table IV and plotted in Fig. 3.

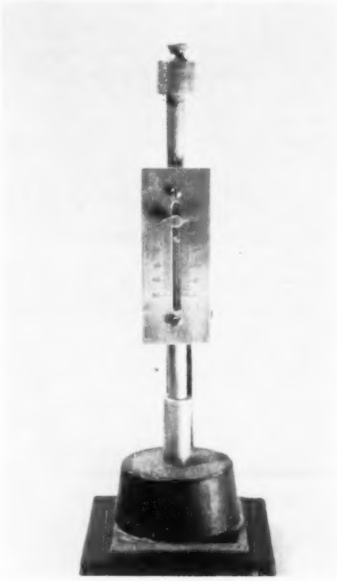

Fig. 2.—Total weight adjustment of shaft, cylinder, and pointer.

Summary

These results indicate that with an increase in air content there is an increase in workability and a corresponding increase in penetration. The flow increases to a slight extent. The penetration test is very sensitive to an increase in workability, whereas the flow test is not. The flow test has the advantage that it covers a wider range of consistency. The Vicat apparatus, however, can be varied by varying the diameter of the needle and the load on it.

[3] *Ibid.*, Part 4, p. 174.

Evaluation of Resistance Strain Gages at Elevated Temperatures

By R. L. BLOSS

To satisfy the need for strain measurements at elevated temperatures a number of types of "high-temperature" strain gages are available. A comprehensive evaluation of these gages is needed because of the lack of available information on their performance and because of difficulty that has been encountered in their use. A facility for conducting such an evaluation is described. Typical results obtained during evaluation tests are given to show the capability of the equipment, to point out some of the problems encountered in the use of these gages, and to illustrate the need for comprehensive gage evaluation prior to use. The results shown are only indicative of the performance of the particular gage tested. Significantly different results might be obtained from other gage types.

TODAY the structural engineer is frequently asked to design high-strength, lightweight structures for operating temperatures that would have been considered disastrous only a few years ago. Successful design depends, of course, upon a sound knowledge of the performance characteristics of structural elements at these temperatures. Since this knowledge can usually be gained only by actual tests, there has been a real need for strain-measuring devices capable of reliable operation over a wide temperature range. In response to this demand a number of strain gages have been placed on the market with claims of usefulness at temperatures as high as 2000 F. Nearly all of these are resistance gages having a fine wire or thin foil as the strain-sensitive element.

Early experience with these gages indicated that serious problems were associated with their use, and results obtained with them were not entirely satisfactory (**1,2,3**).[1] In order that the available type of gage most likely to give meaningful results for a given test condition might be chosen, a comprehensive, comparative evaluation of the existing gage types was needed. Such an evaluation would also be of interest to those engaged in the development of gages, since it could show the desirable and undesirable characteristics of the various materials and gage configurations. Therefore, a program to develop methods, equipment, and techniques for a comprehensive gage evaluation was undertaken at the National Bureau of Standards under the sponsorship of the Bureau of Naval Weapons and Wright Air Development Division.

Scope of Evaluation Program

It was soon found that an evaluation program sufficiently comprehensive to provide complete information for every conceivable gage application would be prohibitively time-consuming and expensive. However, it did seem practical to establish a facility that could give enough performance information to allow the logical selection of a gage type. Since gage performance is sensitive to test conditions and gage history, additional evaluation by the user would be required. However, the availability of information on the gage performance under standardized conditions could minimize the amount of user evaluation required.

In order for an evaluation program to be generally useful, it should provide, as a minimum, the following information:

1. the strain sensitivity (gage factor) over the useful temperature range of the gage,
2. the instability of gage resistance with time and the effect of gage history on this instability,
3. the temperature sensitivity of the gage when installed on a given material and the effect of gage history on this relationship,
4. the strain range that can be measured without gage failure or excessive error, and
5. the ability of the gage to withstand high heating rates and the repeatability of its response under such conditions.

Information about the strain sensitivity is needed because a resistance strain gage is useful only if there is a known relationship between the relative change of gage resistance and the strain to which the gage is subjected. It is usually required that this be a linear relationship within close limits, since the initial strain in the gage element may be unknown. Since it is usually impossible to determine the gage factor for the gages being used in a test program, this factor must be predictable from tests on other gages of the same type. Enough tests must be made to determine whether the gage resistance is a linear function of strain, whether the gage factor is constant for a number of strain cycles, whether the gage factor is dependent upon the direction of loading, whether all gages of one type can be expected to have the same gage factor, and to determine the variation of strain sensitivity with temperature.

Since any change of gage resistance causes a signal from the gage circuit that is the same as would be produced by strain, instability of the gage resistance is of concern. Instability with time has frequently been found to limit the temperature at which the gages may be used, especially for static tests and tests where the mean strain as well as dynamic strain are important. For gages to be useful for these tests, the "drift" must be so low that it contributes a negligible error or so predictable that the necessary corrections can be made. The magnitude of the drift at various temperatures and the effect of gage history on the gage stability

ROSCOE L. BLOSS graduated from University of Colorado (B.S., Engineering Physics) in 1950. He joined the staff of Engineering Mechanics Section, National Bureau of Standards in June, 1950, and has been engaged in research and development of force, strain, and displacement measuring instrumentation since that time. He is a member of American Physical Society, American Association for the Advancement of Science, and Society for Experimental Stress Analysis.

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[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

must therefore be determined. Although the exact values that might be encountered in a given test situation probably cannot be obtained from a general evaluation facility, an indication of probable effects can be given.

The resistance of a mounted gage will usually change with temperature. In general this is because the resistance of the gage and lead materials change with temperature and because the thermal expansions of the gage material and the material to which it is attached are different. Changes in the electrical properties of the cement and lead insulation may also appear as changes in gage resistance. Since the apparent strain due to the temperature-induced resistance changes has to be considered in most test programs, a knowledge of the magnitude and repeatability of this effect is necessary. Such information may be used for presetting instrumentation at one temperature for a test at another temperature or for applying corrections to data for the effects of temperature changes. To be most useful, the form in which the information should be presented depends upon the use to be made of it. A graph of relative change of gage resistance (or apparent strain) as a function of temperature would be most useful for presetting instrumentation or making corrections for large temperature changes. A graph of the temperature derivative of this curve (temperature coefficient of resistance or apparent strain) as a function of temperature would be more useful for making corrections for small temperature fluctuations about a fixed test temperature.

In general, the determination of gage factor values is limited to the elastic region of the material to which the gage is attached, so that information may be obtained for a number of strain cycles and for increasing and decreasing loads. In actual use, the measurement of much larger strains may be necessary. Tests are therefore required to determine the validity of the gage factor value at higher strain levels and to find the magnitude of strain that can be measured before gage failure or excessive error would be expected.

Some of the possible uses for strain gages, such as in simulated re-entry of missiles and space vehicles and nuclear blast effects, involve rapidly changing temperatures. The ability of a gage installation to withstand such treatment and the magnitude and repeatability of its response to such conditions are important.

In addition to the tests required to obtain the minimum amount of gage performance information that is required, evaluation of other characteristics would be desirable. Among these desirable additional tests would be those to determine the fatigue life of a gage type, the effect of dynamic strain history on gage factor, the ability to operate at extremely low as well as at elevated temperatures, and the possibility of compensating for temperature and time effects under a variety of heating conditions.

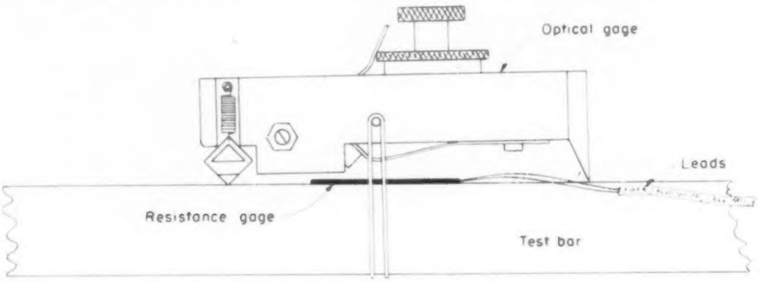

Fig. 1.—Method of determining gage factor.

Evaluation Methods

Equipment and techniques have been developed at the National Bureau of Standards to provide the minimum information described in the preceding section. Effort is being made to increase the scope of the capability of the facility so that additional and more specialized information may be provided when required. In establishing this facility particular attention has been given to reducing the number of laborious, time-consuming tests without loss of useful information, unreasonable reduction of accuracy, or delay to the program.

Strain Sensitivity

Although a number of methods for determining the gage factor of a resistance gage have been described (**4–7**), the precise and reasonably simple method described by Campbell (**4**) was chosen. This method is shown in Fig. 1. The resistance gage is attached to a suitable test bar, connected into an electrical circuit for accurately measuring small resistance changes, and spanned by a sensitive, accurate, previously calibrated extensometer. The Tuckerman optical extensometer (**8,9**) shown is well suited for this use. As the test bar is loaded, simultaneous readings of change of gage resistance and actual strain are taken at suitable intervals until a predetermined maximum strain level, usually about 0.001, is reached. A special testing machine was developed to allow loading a test bar in either tension or compression without change of setup. Figure 2 shows this machine with a specimen mounted and ready for room-temperature gage factor determination.

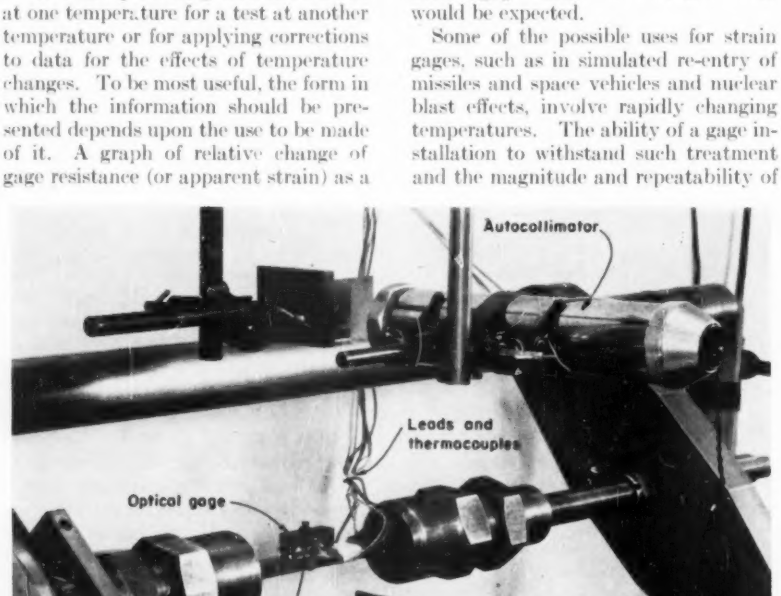

Fig. 2.—Gage factor test setup.

The gage factor is determined as the slope of a straight line fitted to the data for relative change of resistance versus strain. Values are computed for increasing and decreasing tensile and compressive loads. By taking a series of readings during each of a number of strain cycles, information is obtained about linearity, hysteresis, zero shift, and repeatability of the resistance-strain relationship.

Determination of gage factor values at elevated temperatures by the above method is possible by enclosing the test

bar in a furnace and using special high-temperature extensometers (10,11). However, such measurements are time-consuming and quite difficult. Therefore another method has been developed for determining the variation of gage factor with temperature.

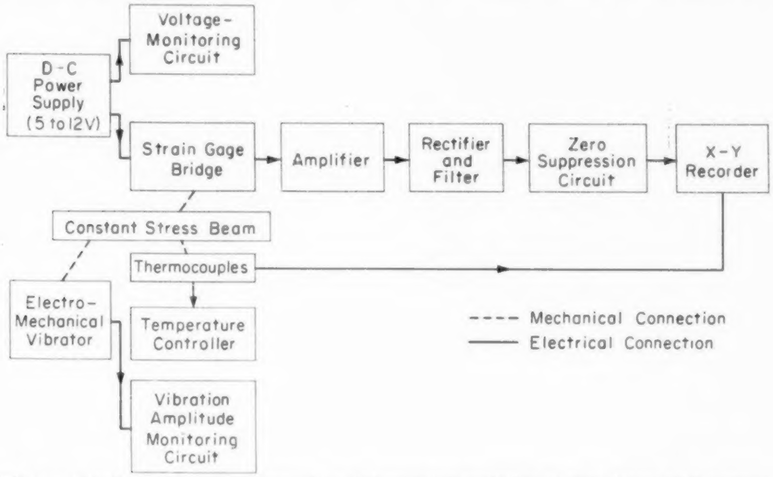

Fig. 3.—Block diagram of equipment for determining variation of gage factor with temperature.

A block diagram of this method is shown in Fig. 3. Figure 4 shows the equipment used. Gages are mounted on opposite sides of a constant-stress cantilever beam and are connected as two adjacent arms of a Wheatstone bridge circuit. The end of the beam is vibrated at a constant amplitude to produce a dynamic strain well within the elastic limit of the beam material. A constant voltage is applied to the input terminals of the bridge circuit, and the temperature of the beam is increased at about 20 F per min. The output signal from the bridge circuit will be the combination of a small alternating voltage of the same frequency as the beam vibration and a direct voltage due to the mean bridge unbalance. If the bridge is nearly balanced, the magnitude of the alternating voltage will be a nearly linear function of the input voltage, of the magnitude of strain to which the gages are subjected, and of the gage factor of the gages. For a beam of given dimensions, the strain is proportional to the end deflection, or amplitude of vibration. Since the input voltage and amplitude of vibration are maintained constant during a test, any change in the magnitude of the alternating voltage will be due to change of gage factor or of the beam dimensions. If the coefficient of linear expansion of the beam material is known, a correction for dimensional changes can be made, thereby providing a record of change of the gage factor with temperature.

In actual practice, the output terminals of the bridge circuit are connected to a network which rejects the d-c component of the signal, amplifies the a-c component to a suitable working level, rectifies the amplified signal, and suppresses it with a constant opposing direct voltage. The suppressed output is then recorded at high sensitivity as a function of beam temperature. The zero-signal reference point is removed by the use of the suppression system, and the absolute output of the sytem is not accurately known. Therefore the sensitivity of the change of the output scale must be determined. This is done by imposing different input voltages on the gage circuit while the temperature and amplitude of vibration are held constant and noting the recorder position for each input voltage. It is assumed that the gage factor remains constant during this time. It can be shown that the change of output signal due to the changing input voltage is the same as would be caused by the same percentage change of gage factor. The scale is marked just before a test is started.

Absolute gage factor values obtained from static tests at room temperature and the variation of gage factor with temperature obtained from the dynamic tests provide complete gage factor information.

Time Stability

The drift of a gage can be measured by holding an unstrained gage installation at a constant temperature while the change of gage resistance is recorded as a function of time. Equipment for ac-

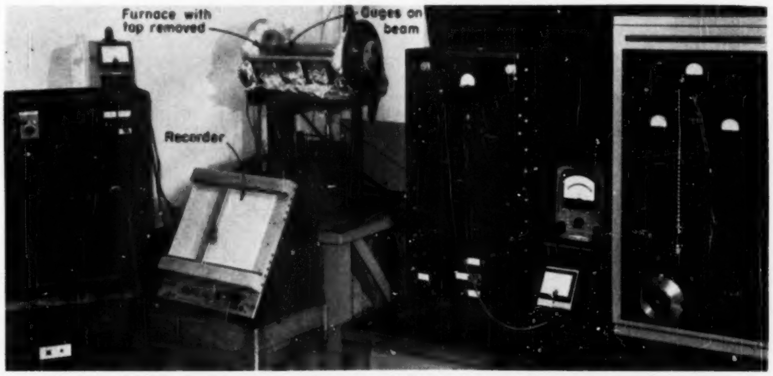

Fig. 4.—Equipment for determining variation of gage factor with temperature.

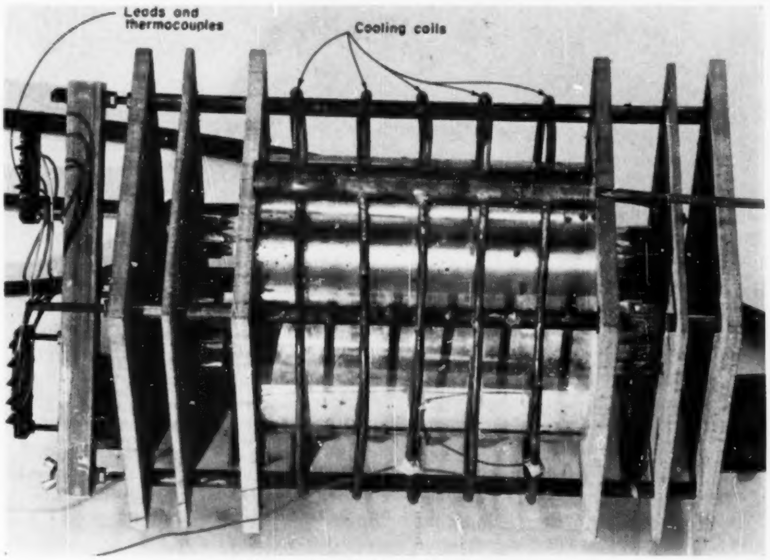

Fig. 5.—Radiant heating furnace.

complishing this is shown in Figs. 5 and 6. A gage attached to a small test strip is suspended at the center of a group of radiant heaters. The entire system is surrounded by a polished aluminum reflecting surface which is cooled by forced air. The gage is connected as one arm of a Wheatstone bridge circuit. The bridge circuit is powered by a constant direct voltage, and the output terminals are connected to an X-Y recorder, the other scale of which is connected to a time-base generator. Power is supplied to the radiant heaters by a power-proportioning controller. Because of the fast response of the controller and low thermal inertia of the system, it is possible to increase the test strip temperature at the rate of about 10 F per sec without excessive overshoot.

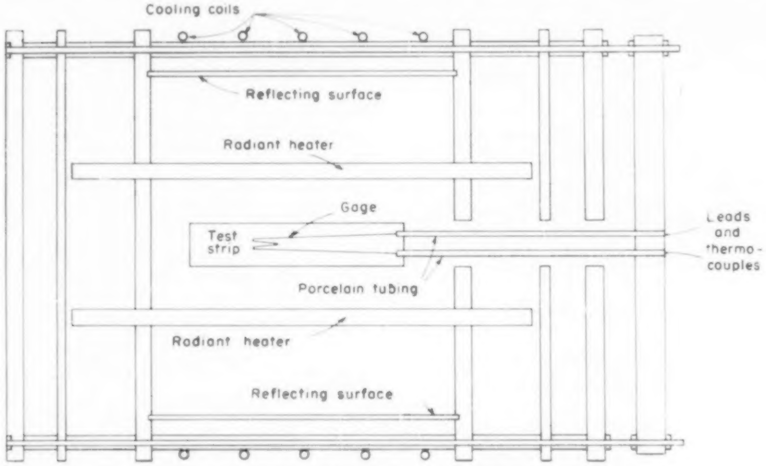

Fig. 6.—Sectional view of radiant heating furnace.

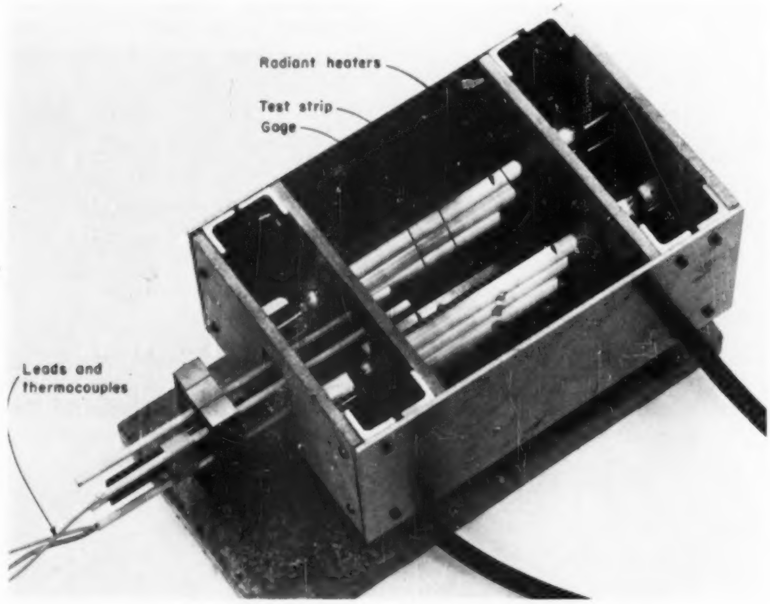

Fig. 7.—Transient heating furnace with top removed.

In conducting a drift test, the test strip is brought rapidly up to the desired test temperature, and subsequent changes in gage resistance are recorded for 30 min. At the conclusion of this period the temperature of the strip is increased to a new test temperature, and the process is continued.

Temperature Sensitivity

The change of gage resistance due to temperature changes can be determined with the equipment used for drift measurements (Figs. 5 and 6) by replacing the time-base generator with a thermocouple. The change of resistance of the gage is then recorded as a function of temperature while the temperature is increasing at the rate of about 10 F per sec.

If only the temperature coefficient of gage resistance is desired, a high recorder sensitivity can be used, and the bridge circuit can be rebalanced during the test if necessary. The temperature coefficient is then taken as the slope of a straight line drawn tangent to the recorded curve at the temperature of interest.

Strain Range

The method and equipment used for determining gage factor (Figs. 1 and 2) may also be used to determine the gage performance at high strain levels. A furnace is mounted on the machine so as to surround the test bar, and special high-temperature extensometers (**10,11**)

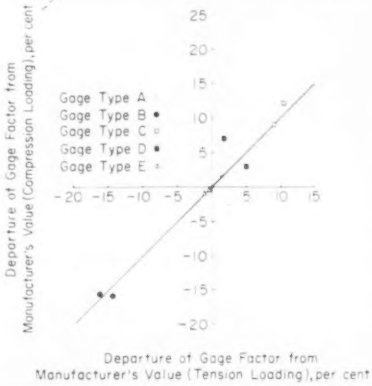

Fig. 8.—Gage factors for five gage types.

are used. With this equipment tests can be conducted at temperatures up to 1000 F and a strains up to 0.01.

Transient Heating

Small test strips with attached gages can be subjected to high heating rates with equipment similar to that used for drift tests. Such equipment is shown in Fig. 7. The test strip is mounted between two banks of radiant heaters

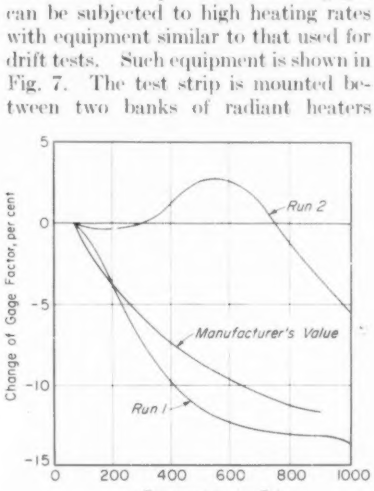

Fig. 9.—Variation of gage factor with temperature for one gage type.

which may be supplied with power at up to twice their rated voltage. The gage is connected as one arm of a bridge circuit, and the change of gage resistance is recorded as a function of temperature as the test strip is heated at a rapid rate.

Heating rates as high as 100 F per sec to a maximum temperature of 1500 F have been obtained with this equipment.

Typical Results

The results given are intended to show the capability of the equipment that has been described, to point out some of the problems that might be encountered in using gages at elevated temperatures, and to illustrate the need for comprehensive gage evaluation. Data from several types of gages have been chosen in order to bring out these points. The results shown indicate the performance of the particular gage tested. The same results would not necessarily be obtained

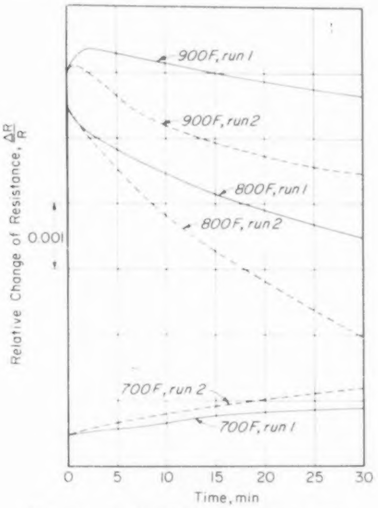

Fig. 10.—Drift behavior of one gage.

from other gage types. All gages were applied according to the manufacturers' instructions.

Strain Sensitivity

The results of strain sensitivity tests are given in Table I and Figs. 8 and 9. Table I gives gage factor values at room temperature for six test runs on each of two gages. Gage No. 1 was loaded three times in tension before being loaded in compression. Gage No. 2 was loaded in compression first.

Figure 8 shows how the room-temperature gage factor values for five gage types differed from the values furnished by the manufacturers. Gage types A, B, C, and D are gages designed for elevated-temperature use. Gage type E is a common room-temperature gage. Each point is the average of two or more runs for each direction of loading. The distance of the points from the origin shows the difference between the gage factor value determined from tests and the value furnished with the gages. The separation of points for a gage type indicates the variation between two gages. The departures of the points from the diagonal line show a difference in gage factor depending upon the direction of loading. This figure shows that the behavior of the elevated-temperature gages is not as good as can be expected from the familiar room-temperature gages.

Figure 9 illustrates the change of gage factor with temperature for two tests of one set of two gages. A curve computed from information furnished by the manufacturer is also shown. The results of the first test run agree quite well with the manufacturer's value. However, the second test run gave very different results. These results were repeated for other gages of this type. Results similar to those of run 2 were obtained from a third test. It should be pointed out that this behavior is not typical of all gage types.

Time Stability

Results obtained during drift tests on one particular gage are shown in Fig. 10. Tests on this gage were conducted at temperatures of 600, 700, 800, 900, and 1000 F. The gage installation was cooled to room temperature, and the test was repeated at the same temperatures. These results show that drift can be a serious problem, that drift may be either positive or negative for the same gage, and that heating a gage installation to a higher temperature does not necessarily stabilize it. This latter point is shown by the larger drift generally shown by this gage during the second test run.

Temperature Sensitivity

The curves of Fig. 11 show the change of resistance and the temperature coefficient of resistance as a function of temperature for one gage installed on stainless steel. As mentioned previously, the form of data presentation that will be most useful depends upon the use to be made of the information.

Strain Range

The results of three tests in which gages were strained in tension until either failure occurred or the limit of the standard extensometer was reached are shown in Fig. 12. The temperatures at which the gages were tested are indicated. Gage type A would seem to be able to measure quite large strains with relatively small errors. The curve for gage type B shows a characteristic failure of the cement bond, as the actual strain increased more rapidly than the strain indicated by the resistance gage. The results for gage type C suggest the possibility of a gage element failure be-

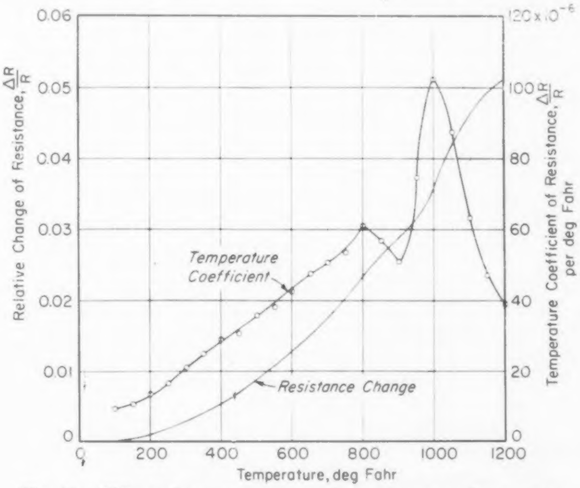

Fig. 11.—Effect of temperature on the resistance of one gage.

TABLE I.—GAGE FACTOR VALUES FOR TWO GAGES.

Run Number	Tensile Loading		Compressive Loading	
	Increasing Load	Decreasing Load	Increasing Load	Decreasing Load
		Gage No. 1		
1	1.842	1.845	...	...
2	1.854	1.844	...	...
3	1.843	1.848	...	...
4	...	...	1.865	1.864
5	...	...	1.874	1.878
6	...	...	1.876	1.878
		Gage No. 2		
1	...	...	1.831	1.834
2	...	...	1.825	1.830
3	...	...	1.831	1.844
4	1.780	1.833	...	...
5	1.788	1.851	...	...
6	1.806	1.823	...	...

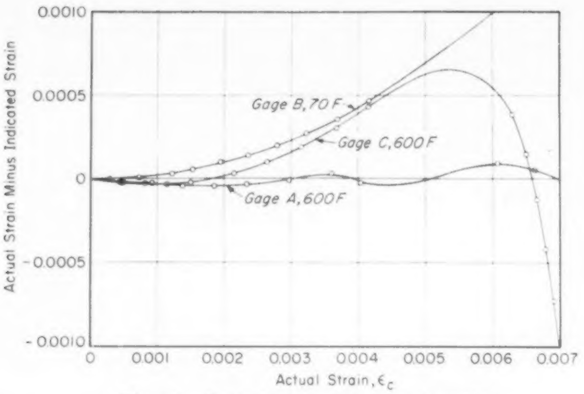

Fig. 12.—Behavior of gages at high strains.

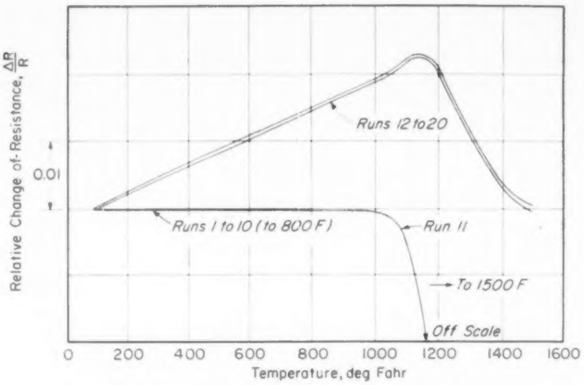

Fig. 13.—Response of one gage to transient heating.

cause of the rapid increase in gage resistance for a small increase in actual strain.

The results obtained from tests to determine the useful strain range of the gages also augment the information obtained in other tests. The test shows the agreement between gage factor values obtained from static and dynamic tests and also shows the linearity of the gage response for static test conditions. Preloading several times to about 0.001 strain before testing at high strain levels provides additional information on linearity, hysteresis, and zero shift.

Transient Heating

Figure 13 shows the results of tests in which the gage installation was heated at the rate of about 60 F per sec. It shows that the response of this gage was quite repeatable and that the change of gage resistance was small at temperatures up to 800 F. When heated to higher temperatures, the gage characteristics are altered so that the change of resistance is much greater, but gage response is still repeatable.

Summary

Equipment and techniques have been developed for obtaining information on the probable performance of resistance strain gages at elevated temperatures. Since some of the performance characteristics are highly dependent upon gage type, test conditions, gage history, and test specimen material, the results obtained in a general evaluation program must be considered to be guides for gage selection and for prediction of trends and of gross magnitude of effects. In general, these results should not be used for the correction of test data unless the tests are to be carried out using the same gage type under the same conditions as those used for the gage evaluation. A general evaluation program is useful, however, in aiding in the selection of a gage type that is most likely to be suitable for a given test condition and in reducing the number of evaluation tests that must be conducted by gage users. The performance shown by gages in tests of this type should also be of great use to gage development personnel by indicating the weak points of a gage type and by comparing the performance of various gage types under standardized conditions.

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DISCUSSION

Mr. A. M. Schwartz.[1]—What type of gages were used?

Mr. R. L. Bloss (*author*).—The results used as illustrations were obtained from a number of types of gages that have been tested in our laboratories. These include gages made from thin foils and fine wires. Most of the gages were attached to test bars by use of ceramic cements, although some were attached by spotwelding. The illustrations are intended to show performance characteristics that might be encountered and the capability of the evaluation equipment. The results are not intended to show the behavior of any one type of strain gage.

Mr. Schwartz.—Using the foil gage with the ceramic cement we notice the installation has a hygroscopic effect. Have you either developed or come across a sealant to prevent the moisture from getting on the installation?

Mr. Bloss.—We have not had any

[1] Testing Engineer, Structures Laboratory, McDonnell Aircraft Corp., Creve-Coeur, Mo.

experience in protecting these gages from moisture. Our procedure has been to store the installed gages for as short a time as possible and in a low-humidity atmosphere if possible. I understand that some of the silicone varnishes have been used to protect the gage installations. I believe that at least one strain gage manufacturer is marketing a waterproofing material for use with ceramic cements. I do not know how effective these materials are.

MR. PETER STEIN.[2]—This paper is an extremely significant one. NASA Standard 942, which has just come out, is the first specification on how a strain gage should be evaluated. It is therefore extremely significant that the author, who has done most of the strain gage evaluation in the past, should present his method.

There is one question I want to ask: The basic gage factor data were obtained on one single specimen which could be subjected to tension and compression. Subsequent data at other ambient conditions, however, were obtained on beams in bending. The new NASA specification calls for all tests to be performed on a single specimen which can be placed in tension and compression. Would you comment on this, to me, unnecessarily complicated requirement?

MR. BLOSS.—It should be possible to obtain gage factor values from either tension and compression tests or bending beam tests if the test design and the data analysis are proper. We chose the tension-compression method and designed a testing machine to allow loading a test bar in either direction without change of setup. The use of this method, with our equipment, becomes more difficult at elevated temperatures. Therefore we found it more convenient to use a vibrating beam method to determine how the gage factor changes with increasing temperature. It should be noted that we determine the change of gage factor, not an absolute value of gage factor, by use of the vibrating beam.

There can be considerable debate about the relative merits of the two general methods of gage factor determination and their refinements. I would only suggest that considerable care must be taken with either method, especially at elevated temperatures.

MESSRS. W. G. BADER[3] AND G. F. WEISSMANN[3] (*by letter*).—The increasing demand for reliable performance data of structures at elevated temperatures has accentuated the importance of strain measuring devices and their reliability at high temperatures. Hence, any new information on the behavior of resistance strain gages at elevated temperatures is most welcome. However, for the information to be of practical value, additional data should be made available to the reader.

Specifically, the author should identify the strain gages evaluated by the gage alloy, the type of gage, whether wire, foil, or monofilament, and the active gage length. Furthermore, the procedures used for applying the gages to the specimens, the cure times and temperatures used for cements, should be specified. Also, information on the use of compensating gages and their environment are necessary for more meaningful results.

Some parts of the experimental procedures appear to be misleading. For example, the strain sensitivity appears to have been determined by means of a single gage attached to one side of a test bar. Under these conditions bending can occur, especially if the load on the test bar is changed from tension to compression. Also, the optical gage seems to have a different gage length compared to the resistance strain gages. The effects of bending and of different gage lengths should be mentioned and evaluated.

Apparently the author measured the temperature sensitivity by means of a single gage placed on a stainless steel strip that was heated in a radiant furnace. In this case, the measured change appears to be caused mainly by the thermal expansion of the test strip. Since the composition of the stainless steel test strip is not mentioned, it is impossible to evaluate this effect. However, the measured changes could be explained by the thermal expansion only, hence this part of the investigation does not provide any information with respect to the performance of the strain gages used. Similar comments can be made with regard to the measurement of the transient heating. A performance as shown in runs 12 through 20 would be expected. The results of runs 1 through 10 should be suspected, because the thermal expansion of the specimen would prevent the gage output from remaining constant.

MR. BLOSS.—Since the purpose of this paper was to show the need for the evaluation of strain gages at elevated temperatures and to describe equipment to carry out the evaluation tests, gages from which illustrations were drawn were not identified. A report showing the performance of a particular gage type would, of course, give all of the information about the gage and the installation procedures that was available and necessary for clarity.

In general the behaviors of individual gages are determined without the use of compensating gages. Compensation can be obtained only if the behaviors of two gages are the same.

It is not only possible but almost certain that some bending will occur when an attempt is made to load a bar in tension or compression. As an approximation it can be assumed that the test bar is initially straight and forms an arc of a circle when loaded, or vice versa. The difference in the strain measured by the optical and resistance gages would be the difference between the arc length and cord length between the optical gage points divided by the initial optical gage length. For the values of optical gage length (2 in.), test bar thickness ($\frac{1}{2}$ in.), and strain (about 0.001) used, bending severe enough to cause the two sides of bar to be loaded in opposite directions would be necessary to produce an error of 0.1 per cent. Tests have indicated that errors of less than 0.02 per cent can be attributed to bending. Of course, attempts to compute surface strains using applied load and modulus of elasticity information could lead to very serious errors. The effect of nonuniform strain is more difficult to evaluate. Care is taken to provide test bars of uniform cross-section. The bars are stress relieved after machining, and it is assumed that they are homogeneous over the optical gage length. Since these precautions are taken, and the test bar is not loaded beyond its elastic limit, the strain should be nearly uniform. It is estimated that errors due to nonuniform strain do not exceed 0.5 per cent. It should also be noted that the effect of nonuniform strain would be present in other methods of gage factor determination.

The temperature sensitivity of the gages would be expected to be due to the coefficient of resistance of the gage element and the strain produced in the gage element due to the difference in coefficients of linear expansion of the gage material and the base metal. These factors, especially the coefficient of resistance, may change due to thermal treatment. The difference between runs 1 through 10 and runs 12 through 20 in Fig. 12 indicates that such a change probably took place during run 11. There is no reason to suspect that all curves of Fig. 12 are not equally valid, since they were obtained from the same gage with the same equipment under the same conditions by the same personnel during the same day. Similar results were obtained for other gages of this type.

I should like to express my appreciation to each of the discussers for bringing out pertinent points and oversights in this paper.

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Fracture Characteristics of Notched Tensile Specimens of Titanium and a Titanium Alloy

By G. W. GEIL and N. L. CARWILE

The effects of notch geometry, temperature, and prior strain-temperature history on the initiation and propagation of the fracture of tensile specimens of titanium and a titanium alloy were revealed in the appearance of the fracture surfaces. Notched specimens of circular cross-section were extended to fracture at 100, 25, −78, and −196 C, or at a combination of two of these temperatures. Initiation of fracture depended primarily upon the notch geometry and only to a minor extent on the temperature. Prestraining of specimens under relatively ductile behavior at 25 C had no significant effect on the appearance of the fracture surfaces obtained in subsequent extension under the much less ductile behavior at −196 C. Initiation of fracture was correlated with embrittlement factors associated with the notch geometry.

IN A TENSION TEST the presence of a notch in a specimen of circular cross-section induces a longitudinal stress concentration in the region at the root of the notch and transverse radial tensile stresses in the minimum cross-section of the specimen. The magnitudes of these two factors depend primarily upon the geometry of the notch, and their effect on the tensile behavior of the specimen is usually quite pronounced. The resistance to flow and other strength indices tend to increase with increased triaxiality[1] (**1**).[2] The ductility of the specimen, however, tends to decrease with increase in either the triaxiality or the stress concentration factor.

It has usually been assumed (**2**) for design under static (steady) stress that the embrittling effect of the stress concentration at the root of a notch is mitigated by a slight amount of plastic deformation and is practically removed when the plastic strain is about 2 per cent (**1,3**). Moreover, it has also been assumed (**3**) that the flow, fracture, and ductility of a notched tensile specimen that has a ductility in excess of 2 per cent strain should be independent of the initial stress concentration factor and should depend primarily upon the transverse tensile stresses superimposed upon the applied longitudinal stress. However, data obtained in this laboratory (**4,5,6**) and in other investigations (**7,8,9**) indicate that the severe work hardening and strain gradients developed in the region adjacent to the root of the notch during deformation also embrittle the specimen and affect the initiation and propagation of the fracture.

"Embrittle" and "embrittlement" as used in this paper refer specifically to a lowering of the ductility of the specimen and not to a decrease in the load-carrying capacity. The load-carrying capacity of a notched tension specimen may be either larger or smaller than that of an unnotched specimen of the same minimum cross-sectional area. It depends primarily upon the relative magnitudes of the following two factors associated with the notch geometry: (1) the increase in the flow stress with increase in the triaxiality, and (2) the decrease in the fracture stress due to a decrease in the strain at fracture. This latter factor generally results in a decrease in the load-carrying capacity if the fracture occurs while the load is increasing and at a strain much less than that of an unnotched specimen at maximum load.

Some data on the appearance of fractures and their propagation in metal tension specimens have been reported (**10,11**), and the atomic mechanisms involved in the initiation and propagation of fractures have been reviewed in detail in a recent publication (**12**). However, very little information is available on the effect of notch geometry, temperature, and prior strain-temperature history on the general appearance of the fracture surfaces, the position of the initiation of fracture, and its propagation across the the specimen. Some information of this type was recently obtained in an examination of the fracture surfaces of notched tension specimens of initially annealed titanium and a titanium alloy, and these data are summarized in the present paper. The effects of notch geometry, temperature, and prior strain-temperature history of the specimens on selected tensile properties were presented in previous publications (**4,5,6**)

Materials, Specimens, and Test Procedures

Materials

The two materials studied in this investigation were a commercially pure titanium (ASTM Specification B 265-58 T, grade 4)[3] and a 4 per cent aluminum, 4 per cent manganese titanium

GLENN W. GEIL is a member of the Thermal Metallurgy Section of the National Bureau of Standards where he has directed projects on the deformation of metals at low temperatures and the effects of notch geometry on the tensile behavior of metals. He is active in the ASTM-ASME Joint Committee on the Effect of Temperature on the Properties of Metals as a member of the Applied Research Panel, Panel on Structural Materials for Airframes and Missiles, and secretary of the Low Temperature Panel.

NESBIT L. CARWILE, a metallurgist in the Thermal Metallurgy Section, has been at the National Bureau of Standards since 1937, and has conducted research studies on deformation of metals at high and low temperatures, and hardenability of steel.

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[1] Triaxiality is determined as the ratio of transverse radial stresses to the applied longitudinal stress.

[2] The boldface numbers in parentheses refer to the list of references appended to this paper.

[3] Tentative Specifications for Titanium and Titanium Alloy Strip, Sheet, and Plate, 1958 Book of ASTM Standards, Part 2, p. 734.

alloy. Both materials were fine-grain (ASTM grain size No. 9 or finer) and were supplied in the form of 1-in. and $\frac{3}{4}$-in. diam bars that were hot rolled and annealed by the producers. The chemical compositions of these materials (per cent by weight, other than titanium) are given in Table I.

Specimens

All specimens were of circular cross-section. The notched specimens (Fig. 1) were machined with a circumferential V-notch[4] of 60-deg angle, a constant minimum diameter of 0.350 in. at the root of the notch, and with selected root radii and notch depths.[5] The root radius was varied from 0.005 to 2.0 in., and to 10 in. for one specimen. The notch depth was varied from 5 to 87 per cent by proper selection of the diameter of the cylindrical portion of the specimen adjacent to the notch.

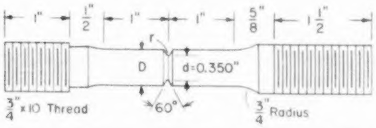

Fig. 1.—Form and dimensions of the notched tension test specimens.

Test Procedures

Tension tests were made in a pendulum hydraulic testing machine at 100, 25, −78, or −196 C, or at two of these temperatures in sequence. The specimens were extended slowly with the deformation rate maintained at about 0.5 to 1.0 per cent contraction in area per min during the deformation beyond initial yielding. Simultaneous load and minimum-diameter measurements were made throughout each test. In the normal (single-stage) tension tests, the specimens were extended to fracture at a selected temperature. In other tests (two-stage), the specimens were extended to selected strains at one temperature and then extended to fracture at a different temperature. Details of the testing procedures are given in previous publications (**13,14,15**).

TABLE I.—CHEMICAL COMPOSITION.

Element	Commercially Pure Titanium	Titanium Alloy (4 per cent Al, 4 per cent Mn)
Aluminum, per cent	0.001–0.01	4.2
Calcium, per cent	Not detected	0.001–0.01
Carbon, per cent	0.04	<0.1
Chromium, per cent	0.01–0.1	0.01–0.1
Copper, per cent	0.0001–0.001	0.001–0.01
Iron, per cent	0.01–0.1	0.1–1.0
Magnesium, per cent	Not detected	0.001–0.01
Manganese, per cent	0.001–0.01	3.8
Nickel, per cent	0.001–0.01	0.01–0.1
Silicon, per cent	0.02	0.1–1.0
Silver, per cent	Not detected	0.0001–0.001
Tin, per cent	0.01–0.1	0.001–0.01
Vanadium, per cent	Not detected	0.01–0.1
Nitrogen[a], per cent	0.04	0.02
Oxygen[b], per cent	0.21	...
Hydrogen[b], per cent	0.012	0.006

[a] Nitrogen was determined by the Kjeldahl method.
[b] Oxygen and hydrogen were determined by a modified vacuum fusion method.

Fracture Surfaces

The two principal factors affecting the initiation of fracture in tension tests on circumferentially notched specimens of circular cross-section are: (1) the embrittling effects associated with the initial stress concentration in the region at the root of the notch and the accompanying severe work hardening and strain gradients, and (2) the embrittling effect of the triaxial stresses induced by the notch. The relative effects of these two factors in initiating the main fracture crack in the titanium and titanium alloy specimens were readily revealed in a study of the appearance of the fracture surfaces. In this study the

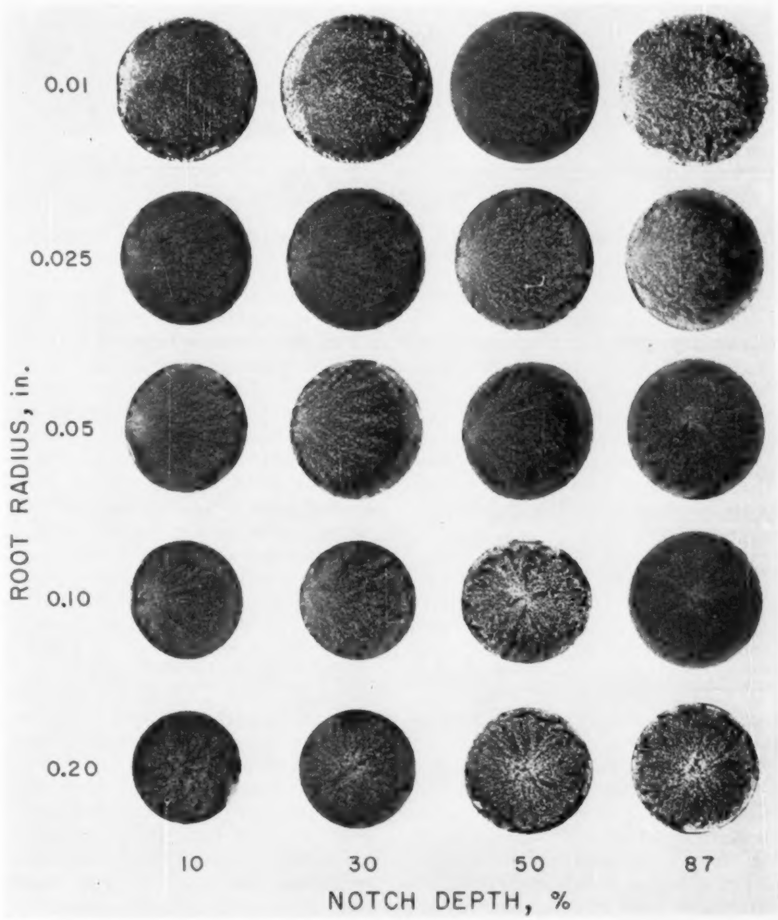

Fig. 2.—Fracture surfaces of notched specimens of titanium that were extended to fracture at 25 C (× 2.5). The chevron markings point back to the position of the initiation of the main fracture crack.

[4] The shape of the V-notch degenerated into a simple groove whose profile was an arc of a circle when the depth of the metal removed in machining the notch was equal to or less than one-half the root radius, that is for the following notches:

Notch Depth, per cent	Root Radius, in.
87	2.0
70	0.5 or greater
50	0.2 or greater
30	0.10 or greater
10	0.025 or greater
5	0.01 or greater

[5] Notch depth is expressed as the per cent of cross-sectional area removed in machining the notch and is equal to $100[(D^2 - d^2)/D^2]$, where d is the minimum diameter at the base of the notch, and D is the diameter of the cylindrical portion of the specimen adjacent to the notch (Fig. 1).

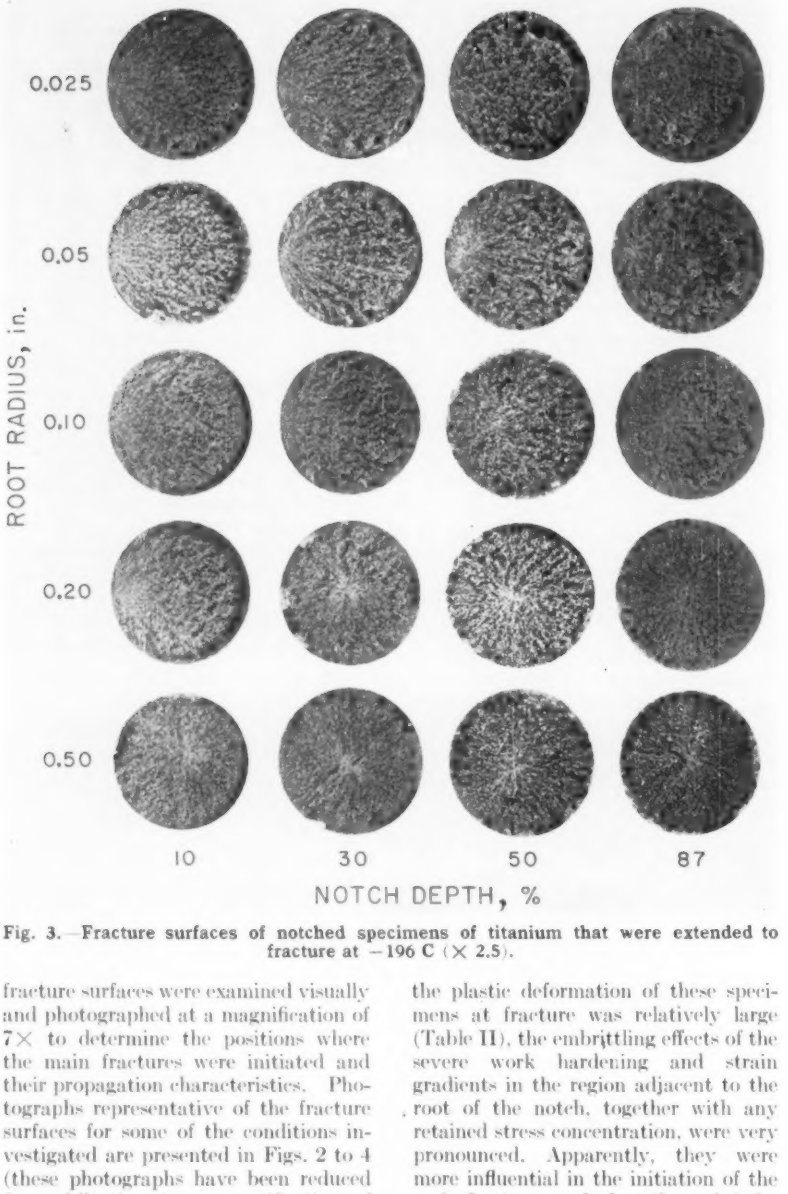

Fig. 3.—Fracture surfaces of notched specimens of titanium that were extended to fracture at −196 C (× 2.5).

fracture surfaces were examined visually and photographed at a magnification of 7× to determine the positions where the main fractures were initiated and their propagation characteristics. Photographs representative of the fracture surfaces for some of the conditions investigated are presented in Figs. 2 to 4 (these photographs have been reduced for publication to a magnification of approximately 2.5×).

Specimens Fractured in Single-Stage Tension Tests

Titanium.—The dependence of fracture characteristics on the notch geometry of the titanium specimens that were extended to fracture in single-stage tests at 100, 25, −78, and −196 C is given in Table II.

The effects of the notch depth and root radius on the appearance of the fracture surfaces of some of the specimens fractured at 25 C are shown in Fig. 2. The fractures of all of the specimens with a root radius of 0.025 in. or less were initiated at or near the root of the notch by the embrittlement predominantly associated with the initial stress concentrations. Even though the plastic deformation of these specimens at fracture was relatively large (Table II), the embrittling effects of the severe work hardening and strain gradients in the region adjacent to the root of the notch, together with any retained stress concentration, were very pronounced. Apparently, they were more influential in the initiation of the main fracture crack than the embrittlement effects of the triaxial stresses. This was true even though the triaxial stresses were relatively large for the deep-notch specimens (Table II). Conversely, the fractures of all of the specimens with a root radius of 0.20 in. (Fig. 2) or greater (not shown) were initiated near the axis of the specimen and propagated radially to the periphery of the minimum cross-section. The embrittling effect of the triaxial stresses (even though they were relatively small in the shallow-notch specimens) was more influential in the initiation of the fracture than the slight embrittling effect of the very small stress concentrations in these specimens with large root radii.

The relative difference in the effects of these two notch-embrittling factors on the initiation of the crack apparently was quite small for the specimens with root radii greater than 0.025 in. but less than 0.20 in. For example, the fractures of the specimens with root radii of 0.05 and 0.10 in. (Fig. 2) were initiated at the roots of the notches in the shallow-notch specimens, whereas the fractures were initiated near the axes in the deep-notch specimens. Moreover, this transition in the location of the fracture initiation occurred at a smaller notch depth in the specimens of the larger root radius. Thus, this range of root radii may be regarded as a "fracture transition range" for the notched specimens of titanium extended in tension at 25 C.

The fracture surfaces obtained at 25 C of specimens with notch depths or root radii beyond the ranges included in Fig. 2 can be depicted in relation to those shown as follows: (1) The mode of fracture initiation and propagation in the specimens with a notch depth of 5 per cent depended upon the root radius in a manner identical to that in the specimens with a notch depth of 10 per cent. (2) The mode of fracture initiation and propagation in the specimens with a root radius of 0.005 in. was very similar to that shown for the specimens with a root radius of 0.01 or 0.025 in.—the fractures started at the root of the notch and propagated diametrically across the minimum cross-section, and they were independent of the notch depth. (3) The fractures of the two series of specimens with root radii of 0.5 and 2.0 in. and of selected notch depths started near the axis and propagated radially to the pheriphery in a manner similar to that shown (Fig. 2) for the specimens with a root radius of 0.20 in.

The mode of fracture initiation and propagation, as revealed by the appearance of the fracture surfaces (not shown), in notched specimens extended in tension at 100 and −78 C was practically identical to that obtained at 25 C in correspondingly notched specimens. This relationship was obtained even though the ductility of the specimens was appreciably less at −78 C than at 25 or 100 C. Thus, within the range of 100 to −78 C, the specific effect of temperature on the two-notch embrittlement factors was practically insignificant. However, at −196 C the embrittlement associated with the stress concentrations was enhanced due to the very low ductility of the specimens. As the true strain at fracture (Table II) of the specimens at −196 C was generally less than one-fourth that of correspondingly notched specimens at 25 C, the mitigation by plastic deformation of the embrittlement associated with the initial stress concentrations was less than that at 25 C. Hence, the "fracture transition range" of root radii was ex-

panded to larger radii (Fig. 3) and included a specimen with a radius as large as 0.5 in., in which the fracture (Table II) was initiated at or near the root of the notch.

Fracture of specimens in which embrittlement associated with triaxiality was predominant generally started at or near the axis. This indicated that the axis region was the locale of maximum triaxiality. However, in a few deeply notched specimens tested at −78 and −196 C, in which the true strain at fracture was very small (0.02 to 0.05), a fully developed triaxiality condition apparently was not attained; these fractures were initiated between the axis and the root of the notch. The position of the initiation of these fractures, however, approached the axis with increase in the strain at fracture, indicating an approach to a fully developed triaxiality condition.

At a selected temperature, the ductility of notched specimens of constant notch depth, in which the fracture was initiated at or near the root of the notch, was less (Table II) than that of the specimens in which the fractures were initiated at or near the axis. This feature was presented in considerable detail in a previous paper (**6**).

Titanium alloy.—A limited study was made of the effect of notch geometry on the fracture characteristics of tension specimens of an annealed titanium alloy containing 4 per cent aluminum and 4 per cent manganese. The specimens were extended to fracture in single-stage tests at 25 C. A study of the fracture surfaces (not shown) revealed that the dependence of the fracture initiation and propagation on the geometry of the notch was very similar to that observed for the titanium. However, due to the lower ductility of the alloy specimens, the mitigation by plastic deformation of the embrittlement associated with the initial stress concentration apparently was even less than that in the titanium specimens. This was indicated by the initiation of the fractures at the root of the notch of all alloy specimens with a root radius of 0.05 in. or less, whereas the titanium specimens with a root radius of 0.05 in. were within the "fracture transition range."

Specimens Fractured in Two-Stage Tension Tests

A study was made to determine the effect, if any, of prior plastic deformation of the titanium and titanium alloy

TABLE II.—EFFECTS OF NOTCH GEOMETRY AND TEMPERATURE ON FRACTURE CHARACTERISTICS OF CYLINDRICAL TENSION SPECIMENS OF INITIALLY ANNEALED TITANIUM.

Notch Factors				Fracture Characteristics							
				True Strain,[c] at Temperature				Fracture Initiation,[d] at Temperature			
Notch Depth, per cent	Root Radius, in.	Stress Concentration Factor,[a] K_t	Triaxiality,[b] S_t/S_e	100 C	25 C	−78 C	−196 C	100 C	25 C	−78 C	−196 C
10.....	0.005	3.5	0.08	...	0.21	...	0.03	...	R	...	R
30.....	0.005	4.7	0.22	...	0.09	...	0.02	...	R	...	R
50.....	0.005	5.3	0.35	0.12	0.06	0.02	0.01	R	R	R	R
87.....	0.005	5.8	0.48	0.09	0.05	0.01	0.01	R	R	R	R
5.....	0.01	2.3	0.03	0.55	0.28	0.12	0.05	R	R	R	R
10.....	0.01	2.7	0.08	0.38	0.22	0.10	0.03	R	R	R	R
30.....	0.01	3.5	0.22	0.18	0.14	0.03	0.02	R	R	R	R
50.....	0.01	3.9	0.35	0.13	0.08	0.03	0.02	R	R	R	R
70.....	0.01	4.1	0.44	0.13	0.08	0.03	0.02	R	R	R	R
87.....	0.01	4.2	0.47	0.14	0.08	0.02	0.01	R	R	R	NR
10.....	0.025	2.1	0.08	...	0.30	...	0.05	...	R	...	R
30.....	0.025	2.5	0.22	...	0.17	...	0.03	...	R	...	R
50.....	0.025	2.7	0.34	0.21	0.14	0.07	0.03	R	R	R	R
70.....	0.025	2.7	0.39	...	0.17	...	0.03	...	R	...	NR
87.....	0.025	2.8	0.44	0.25	0.19	0.07	0.02	R	R	R	NR
5.....	0.05	1.6	0.03	0.63	0.49	0.25	0.12	R	R	R	R
10.....	0.05	1.7	0.08	0.53	0.36	0.20	0.08	R	R	R	R
30.....	0.05	1.9	0.22	0.33	0.25	0.13	0.04	R	R	R	R
50.....	0.05	2.0	0.32	0.34	0.22	0.12	0.05	NR	R	R	NR
70.....	0.05	2.1	0.35	0.37	0.23	0.12	0.05	A	A	A	NR
87.....	0.05	2.1	0.40	0.32	0.21	0.09	0.03	A	A	A	A
10.....	0.10	1.4	0.08	0.69	0.53	...	0.11	R	R	...	R
30.....	0.10	1.6	0.20	0.59	0.45	0.26	0.08	NR	R	R	R
50.....	0.10	1.6	0.28	0.50	0.36	0.21	0.06	A	A	A	A
70.....	0.10	1.6	0.29	...	0.25	...	0.04	...	A	...	A
87.....	0.10	1.6	0.33	0.37	0.22	0.07	0.04	A	A	A	A
5.....	0.20	1.2	0.03	...	0.65	...	...	...	A	...	...
10.....	0.20	1.3	0.08	0.74	0.54	0.42	0.16	A	A	A	NR
30.....	0.20	1.3	0.18	0.61	0.47	0.34	0.13	A	A	A	A
50.....	0.20	1.3	0.23	0.53	0.36	0.18	0.06	A	A	A	A
70.....	0.20	1.3	0.24	...	0.34	...	0.04	...	A	...	A
87.....	0.20	1.3	0.24	0.46	0.32	0.14	0.04	A	A	A	A
5.....	0.50	1.1	0.03	...	...	...	0.22	...	...	...	NR
10.....	0.50	1.1	0.08	0.69	0.57	...	0.20	A	A	...	A
30.....	0.50	1.1	0.13	...	0.47	...	0.09	...	A	...	A
50.....	0.50	1.1	0.15	0.56	0.42	0.28	0.06	A	A	A	A
70.....	0.50	1.2	0.15	...	0.50	...	0.06	...	A	...	A
87.....	0.50	1.2	0.15	0.62	0.44	0.30	0.06	A	A	A	A
5.....	2.0	1.03	0.03	...	0.64	...	0.22	...	A	...	A
10.....	2.0	1.03	0.06	0.70	0.60	0.43	0.19	A	A	A	A
30.....	2.0	1.03	0.07	...	0.56	...	0.20	...	A	...	A
50.....	2.0	1.03	0.07	0.69	0.55	0.39	0.16	A	A	A	A
70.....	2.0	1.03	0.07	...	0.57	...	0.16	...	A	...	A
87.....	2.0	1.03	0.07	0.67	0.57	0.42	0.22	A	A	A	A
50.....	10.0	1.00	0.03	...	0.61	...	...	...	A	...	...

[a] Values of the theoretical stress concentration factor are derived from stress concentration design charts, reference (**2**).

[b] Values of the triaxiality are determined as the ratio of the transverse radial stress to the longitudinal stress and are based on the method proposed by Sachs and Lubahn, reference (**1**).

[c] True strain at fracture was determined as the true strain of the specimen immediately preceding the very rapid propagation of the fracture crack.

[d] R and NR: fracture initiated at root of notch, or near root of notch, and propagated diametrically across the minimum cross-section. A: fracture initiated near the axis (or at a considerable distance from the root of the notch) and generally propagated radially to the periphery of the minimum cross-section.

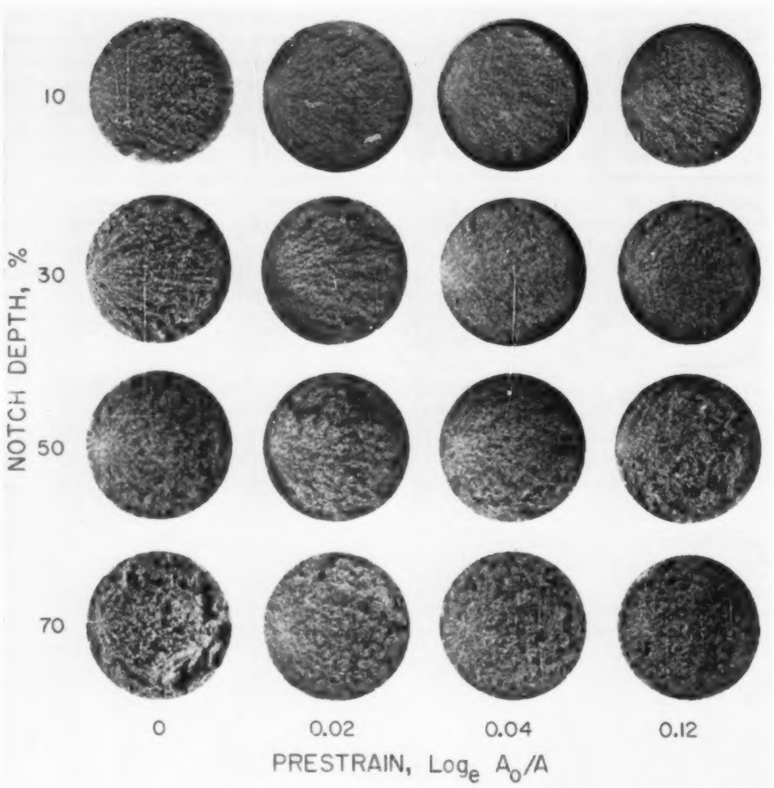

Fig. 4.—Fracture surfaces of titanium specimens with a root radius of 0.05 in. that were prestrained at 25 C to selected true strains and then extended to fracture at −196 C (× 2.5).

under relatively ductile conditions on the appearance of the surfaces of fractures obtained in subsequent deformation under much less ductile conditions. Notched specimens were prestrained at 25 C to selected true strains and subsequently extended at −196 C to fracture. Photographs of the fracture surfaces of some of the titanium specimens are shown in Fig. 4. Prestraining of the notched specimens at 25 C to true strains of 0.02, 0.04, and 0.12 did not significantly change the appearance of the fracture surfaces obtained at −196 C nor the embrittling conditions controlling the position of the initiation of the main fracture cracks and their propagation across the specimens. The positions at which the fractures were initiated were independent of the prestrain and depended primarily upon the notch geometry and its embrittling effects at −196 C.

A study of the fracture surfaces of the alloy (not shown) obtained at −196 C on notched specimens that were prestrained at 25 C to selected true strains of 0.02, 0.04, and 0.08 revealed a fracture pattern very similar to that obtained on the titanium specimens. The position of the initiation of the fracture depended primarily upon the notch geometry and was independent of the prestrain.

Conclusions

Examination of the fracture surfaces of notched tension specimens of titanium and 4 per cent aluminum, 4 per cent manganese titanium alloy revealed that the initiation of the main fracture crack depended primarily upon the geometry of the notch and its embrittling effects. These embrittlement effects were: (1) the initial stress concentration and accompanying severe work hardening and strain gradients in the region adjacent to the root of the notch, and (2) the induced triaxial stresses. The position of the initiation of the fracture depended upon which one of these two embrittlement factors was predominant for the selected notch geometry; it depended only to a minor extent on temperature within the range of 100 to −196 C.

Plastic deformation of the notched specimens did not greatly mitigate and certainly did not completely remove the embrittlement associated with the initial stress concentrations in the region adjacent to the root of the notch. This was evidenced by the initiation of fractures at or very near the root of the notch of specimens that had undergone relatively large true strain prior to fracture. Moreover, prestraining of notched specimens under relatively ductile behavior at 25 C did not completely remove the embrittlement associated with the initial stress concentration in subsequent extension of the specimens to fracture at −196 C. The results of this study indicate nonconformity, at least for these two metals and probably for some other metals, with the assumption often made for designing under steady stress that the embrittlement due to the initial stress concentration at the root of the notch can be neglected if the material has sufficient ductility to undergo plastic deformation of the order of 2 per cent strain or greater. These data emphasize the desirability of eliminating, whenever possible, all notches in designing for the service of these metals at room and subzero temperatures. If notches are unavoidable, then the root radius should be as large as permissible.

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A Stainless Steel for Standard Weights

S. J. ROSENBERG AND T. P. ROYSTON

Requirements for a material for use as a mass standard are that it be corrosion-resistant, nonmagnetic, and have a density of 8.4 g per cu cm. A stainless steel having these characteristics was developed.

BY LONG established custom, the values of weights have been expressed as weightin air again ststandards having a density of 8.4 g per cu cm. Weights that have this density may be compared without a correction for air buoyancy being required.

Brass having a density of 8.4 g per cu cm has been used for many years as material for standard weights. It is nonmagnetic, a necessary property for standards of mass. It is not, however, an ideal material, since it tarnishes, and thus is subject to changes in weight. It would seem that a more suitable material would be stainless steel, provided the two requirements of density and nonmagnetism could be met.

It was obvious that the commercial AISI austenitic stainless steels could meet the nonmagnetic requirement but not that of density. In order to increase the density, the addition of a heavy element was indicated.

Of the various heavy elements, tungsten appeared to be the most promising, despite the fact that it could be expected to promote the formation of ferrite, and hence, cause an increase in permeability. It appeared possible, however, to maintain austenite stability by proper balance of chromium and nickel.

Several experimental steels were melted and fabricated. Melting was carried out in air in a 16-lb laboratory induction furnace and the metal was poured into the form of $1\frac{1}{2}$-in. diameter bars. These were given a 4-hr homogenizing anneal in vacuum at 2000 F prior to hot working. The steels were hot worked by forging and swaging to rods of about 0.6-in. diameter. Hot working was carried out in the temperature range of about 2100 to 1600 F.

After hot working, the rods were cut into lengths of about 6 in. and turned between centers for cleanup. Samples of the cleaned hot-worked material were then taken for spectrochemical and chemical analyses and for determination of density and magnetic permeability.

Other portions of the hot-rolled rods were cold rolled to thin strip (0.008 in.), intermediate vacuum anneals of 1 hr at 2000 F being interposed when considered necessary. No particular difficulty was experienced in either hot or cold working the compositions deemed suitable for mass standards. The analyses of the two steels most closely approaching the desired density are shown in the following table:

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SAMUEL J. ROSENBERG, Metallurgist, National Bureau of Standards, is a mechanical engineering graduate of the George Washington University, 1924. His early work was concerned chiefly with the wear of metals. More recently he has been concerned with the heat treatment and properties of steels, particularly high-strength and stainless steels.

THOMAS P. ROYSTON, Science Technician, National Bureau of Standards, served in the U. S. Army from 1944 to 1945. Since then he has worked on various steel research projects.

National Bureau of Standards Mark	Per cent						
	Carbon	Manganese	Silicon	Chromium	Nickel	Tungsten	Nitrogen
SW-12...	0.09	1.7	1.55	16.2	32.4	9.9	0.017
SW-13...	0.05	1.7	1.49	16.4	32.2	9.9	0.017

Determinations of permeability and density gave the following values:

National Bureau of Standards Mark	Magnetic Permeability (H = 300 Oersteds)			Density, g per cu cm	
	As Hot Worked	As Annealed	As Cold Worked	As Hot Worked	As Annealed
SW-12........	1.008	1.019	1.03	8.42	8.44
SW-13........	1.009	1.024	1.03	8.45	8.45

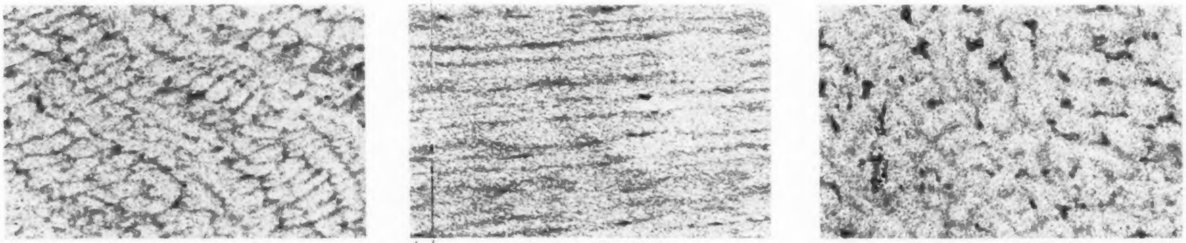
It was rather surprising to obtain an increase in magnetic permeability after annealing the hot-worked material. The remanent induction of the hot-worked specimens was measured after they had been subjected to magnetizing forces of several thousand oersteds. The measured remanent induction was negligible in comparison with the earth's field.

No corrosion tests were made, as it was anticipated from the composition that corrosion resistance would be more than adequate.

Metallographic examination of these steels showed them to contain a large amount of a second phase that apparently could not be taken into solid solution at 1950 F. X-ray diffraction patterns obtained on specimens both in the hot-worked and in the annealed condition showed the second phase to be a Laves phase of the composition Fe_2W. The matrix did not show the austenitic structure that is typical of most of the AISI 300-series steels. Some representative photomicrographs are shown in Figs. 1 and 2.

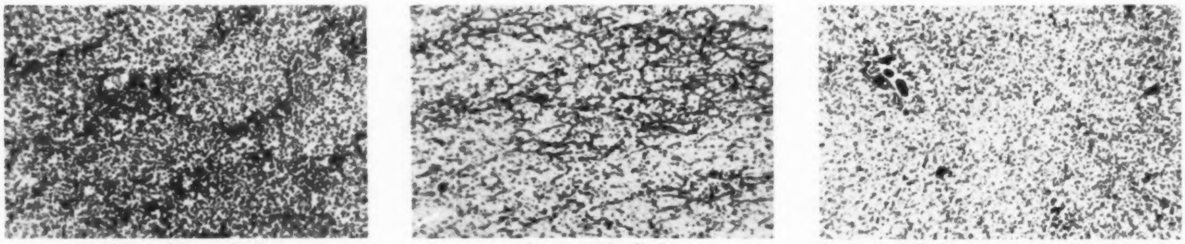
It is believed that the following desired composition and composition range will be suitable for standard weights, subject to experimental determination of mass constancy:

	Composition, per cent	
	Desired	Range or Maximum
Carbon........	0.10	0.20 max
Manganese.....	1.70	2.00 max
Phosphorus....	...	0.040 max
Sulfur.........	...	0.030 max
Silicon.........	1.25	1.60 max
Chromium.....	16.5	15.5 to 17.5
Nickel.........	32.5	31.5 to 33.5
Tungsten......	9.5	9.0 to 10.0



(*a*) As hot worked. (*b*) As cold rolled. (*c*) As annealed (water quenched from 1950 F).

Fig. 1.—Microstructures of steel SW-12 after different treatments. Etched electrolytically in 10 per cent oxalic acid (× 100).



(*a*) As hot worked. (*b*) As cold rolled. (*c*) As annealed (water quenched from 1950 F).

Fig. 2.—Microstructures of steel SW-12 after different treatments. Etched electrolytically in 10 per cent oxalic acid (× 500).

Determination of the Mechanical Properties of Elemental Sulfur

By J. M. DALE

Specimens of dark, standard bright, and laboratory-grade sulfur were tested for strength in specially prepared laboratory apparatus and measurements recorded at 1, 7, and 28 days from the date of casting. It was found that elemental sulfur has an approximate ultimate tensile strength of 160 psi, and an approximate ultimate compressive strength of 3300 psi, with an approximate modulus of rupture of 200 psi. Impurities, as found in the dark and standard bright grades of sulfur, appear to increase strength. Also, strengths were found to increase with increased age of the specimens.

Because of the high mechanical properties exhibited by elemental sulfur, it can be properly looked upon as a structural material. Thus, a great deal more research should be done in evaluating further the mechanical properties of sulfur and exploring the many possible applications where its mechanical properties can be used to advantage.

Sulfur occurs naturally as a solid. Over 6 million tons of this material are produced annually in the United States alone. Although sulfur mixed with sand or carbon has been used for over 30 years as a structural material (**1–5**),[1] little is known of the mechanical properties of solid elemental sulfur alone. After failing to find any data in the literature, the author requested information from research departments of the world's two largest sulfur producers. The replies from both of these organizations were consistent and verified the lack of information on the mechanical properties of elemental sulfur.

The fact that elemental sulfur has reasonably good structural properties can be inferred from past uses of this material. For years it has been the practice in many machine shops to grout machines with elemental sulfur. Sulfur has been used in acid-resistant mortars as an additive in amounts up to 50 per cent. Sulfur has been used to cap bearing surfaces on the ends of concrete blocks and compression test specimens so as to provide a plane surface that can be loaded uniformly when they are tested in compression testing machines. Solid sulfur, which can have a specific gravity as great as 2.07, has supported its own weight in vertical-walled vats without supporting sides to heights as great as 75 ft.

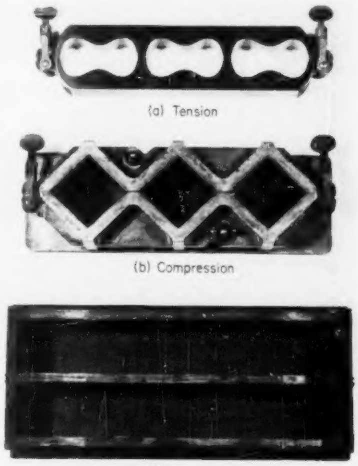
Before new uses for a material can be evaluated, it is necessary to know the properties of the material. Thus, the objective of this project was to determine the mechanical properties of elemental sulfur.

Experimental Procedure and Results

The research program for this project was divided into three separate parts: (1) the acquisition of representative test material, (2) the preparation of test specimens, and (3) the physical testing of the specimens.

Acquisition of Test Material

The majority of the sulfur produced in the United States comes from the cap rock of certain salt domes located along the Gulf Coast. This sulfur is extracted by the well-known Frasch process. Superheated water is pumped into the underground stratum of porous limestone impregnated with sulfur—thus melting the sulfur. The melted sulfur is then pumped to the surface, where it is poured into large open vats and allowed to solidify. In many of the working mines, the sulfur-bearing formation is in association with varying amounts of petroleum. The sulfur produced from these mines does not have the characteristic straw-yellow color of laboratory-grade sulfur but is dark, approaching a brownish-green. Other mines sell their sulfur to industry in the exact form in which it is produced. This material, termed "standard bright grade," has a color that lies between the laboratory grade and the dark grade. While the dark grade of sulfur produced at many mines analyzes over 99 per cent sulfur, producers experience difficulty in marketing this material, and in many cases they treat their dark sulfur as it comes from the wells to bring its color up to that of the standard bright grade.



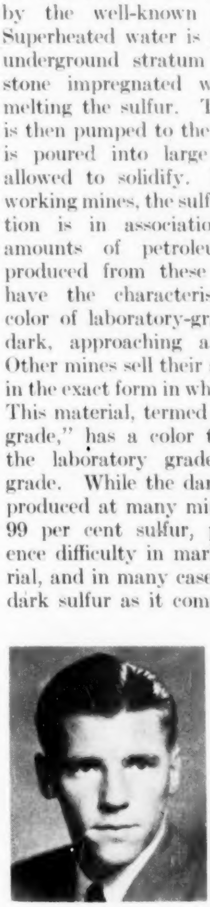
(a) Tension

(b) Compression

(c) Flexure

Fig. 1.—Specimen molds.

Care was taken in securing the test material to see that the test results would cover the product of more than one mine and more than one grade of sulfur. In requesting material from the various producers, emphasis was



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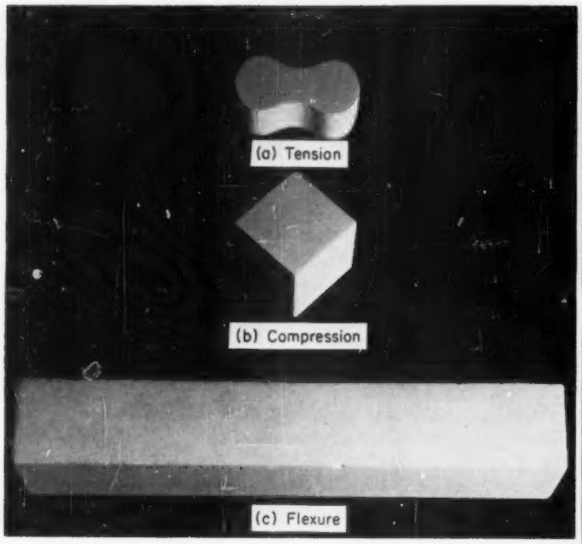


Fig. 2.—Test specimens.

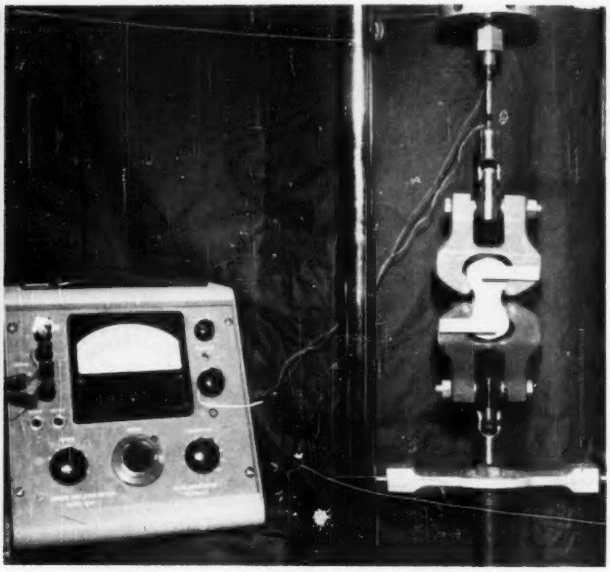


Fig. 3.—Facility for testing tension specimens.

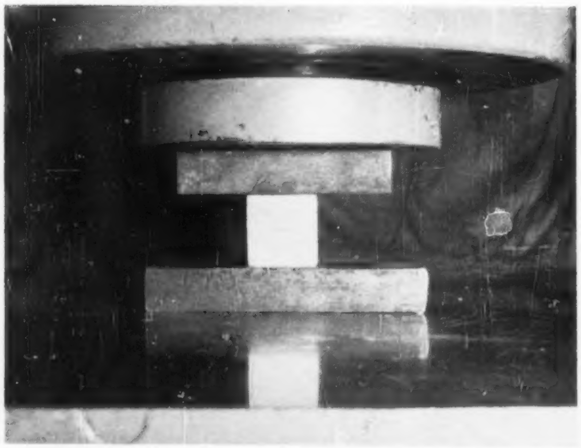


Fig. 4.—Facility for testing compression specimens.

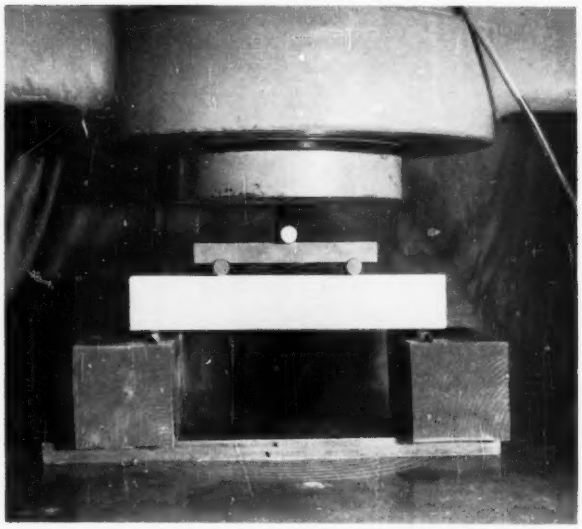
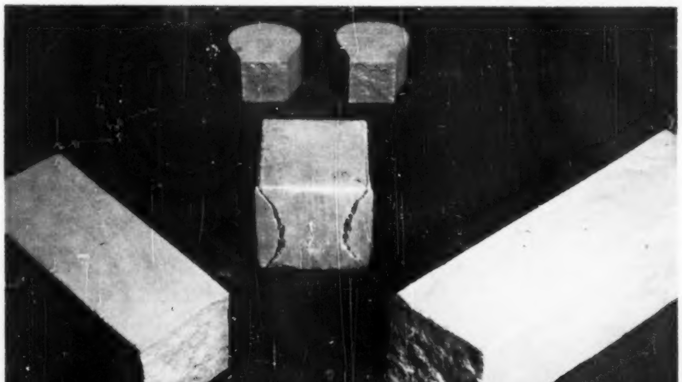


Fig. 5.—Facility for testing flexure specimens.

placed on receiving material that could be considered typical run-of-the-mine material. The inventory of sulfur obtained before any laboratory work was undertaken consisted of dark, standard bright, and laboratory grade. This material originated from four separate mines located on the Texas-Louisiana Gulf Coast.

Preparation of Test Specimens

Since there is no ASTM or other test procedure established for testing sulfur, a study was made of various testing techniques to determine which might lend itself to this work. The test procedures for testing concrete appeared to lend themselves most readily to the study of the mechanical properties of elemental sulfur. Therefore, standard concrete specimen molds for tension, compression, and flexural specimens were obtained. Photographs of these specimen molds are shown in Fig. 1.



(*top*) tension, (*center*) compression, (*bottom*) flexure.
Fig. 6.—Characteristic failures of test specimens.

To allow for shrinkage in the sulfur as it solidifies or freezes, risers or dams were placed above the specimen molds so that the test specimens would not contain voids. After the material had solidified, the excess riser material was cut off with a band saw and the specimen returned to its specified dimension by sanding on a belt sander.

The sulfur was melted in kettles in small electric ovens and was ladled from kettles into the molds and allowed to cool in air. All of this work was done within the laboratory building with an ambient room temperature which is maintained between 60 and 70 F. After pouring, it was the practice to ladle additional liquid sulfur into the mold, as make-up for shrinkage during solidification. A photograph of typical test specimens prepared in this manner is shown in Fig. 2.

Physical Testing of Specimens

1. Tension Specimens.—For testing the tension specimens, special grips were obtained and adapted to a Dillon tension testing machine. To increase the sensitivity of this machine, a special strain-gage dynamometer link with a round center section was fabricated from aluminum and placed in series with the grips. The strain gages were attached on opposing sides of this link and measurements were read from an Ellis bridge amplifier. A photograph of this facility with a sulfur specimen mounted in the grips is shown in Fig. 3.

2. Compression Specimens.—Compression specimens were placed between two flat plates and tested in a 200,000-lb capacity Baldwin universal hydraulic testing machine. A photograph of this test facility is shown in Fig. 4.

3. Flexural Specimens—For testing the flexural specimens, a special fixture was fabricated to provide quarter-point loading, the ends being simply supported. The Baldwin universal testing machine was also used in this test. A photograph of the test facility for testing the flexural specimens is shown in Fig. 5.

Test Results

A photograph of characteristic specimen failures is shown in Fig. 6. In tension, the specimens characteristically broke across the necked-down or 1-sq. in. center section. In compression, the typical cup-cone type failures were encountered. In bending, rather clean failures occurred at or near the center of the span.

The laboratory test data are shown in Table I and plotted in Fig. 7. This figure illustrates the effects of variations in grade and age on ultimate tensile strength, ultimate compressive strength, and modulus of rupture.

Discussion

Ordinary run-of-the-mine commercial sulfur melts at about 235 F to form an amber, mobile liquid, which, if heated above 310 F, becomes more viscous and changes to a dark brown color. Sulfur has a large number of allotropic forms in both the liquid and solid state. On solidification, the two most commonly found allotropic crystalline modifications are the rhombic and monoclinic systems. Within several hours after casting, the monoclinic crystals, unstable at room temperature, change to the rhombic system. No attempt was made in this study to identify the crystalline varieties of the rhombic system obtained in the castings. The major change from the monoclinic system to the rhombic system was observed in the castings by their change in color from a light amber immediately after casting to the final characteristic color in 4 to 6 hr after casting. The castings remain sensitive to temperature, and further changes in temperature cause audible internal cracking.

In melting the sulfur in kettles in small electric ovens, and ladling the sulfur into the specimen molds, it was difficult to control the temperature of the material from which the specimens were prepared. In view of this, no attempt was made to correlate strength with melt temperature.

TABLE I.—LABORATORY TEST DATA.

Melt and Specimen Number	Mine	Specimen Age at Test, days	Tensile Strength, psi	Compressive Strength, psi	Modulus of Rupture, psi
			Dark Grade		
1A	No. 1	1	125	2250	...
1B	No. 1	1	120	3130	305
1C	No. 1	1	140	2750	...
1D	No. 1	1	180	3390	...
1E	No. 1	1	180	3140	254
1F	No. 1	1	140	3520	...
Average			147	3030	...
1G	No. 1	7	135	4190	...
1H	No. 1	7	185	3440	146
1I	No. 1	7	170	3620	...
1J	No. 1	7	150	3250	...
1K	No. 1	7	180	5580	202
1L	No. 1	7	210	2380	...
Average			172	3750	...
1M	No. 1	28	150	4450	...
1N	No. 1	28	130	5230	530
1O	No. 1	28	110	5540	...
1P	No. 1	28	150	4500	...
1Q	No. 1	28	125	3630	540
1R	No. 1	28	170	3060	...
Average			139	4400	...
			Standard Bright Grade		
2A	No. 2	1	175	2900	...
2B	No. 2	1	185	3020	113
2C	No. 2	1	185	3220	...
2D	No. 3	1	180	3070	...
2E	No. 3	1	180	2620	103
2F	No. 3	1	165	3250	...
Average			178	3010	...
2G	No. 2	7	100	625	...
2H	No. 2	7	150	2630	71
2I	No. 2	7	120	1260	...
2J	No. 3	7	120	560	...
2K	No. 3	7	130	2060	47
2L	No. 3	7	100	1330	...
Average			120	1410	...
2M	No. 2	28	155	4070	...
2N	No. 2	28	150	4540	150
2O	No. 2	28	175	6660	...
2P	No. 3	28	310	4260	...
2Q	No. 3	28	310	4740	260
2R	No. 3	28	120	3740	...
Average			203	4670	...
			Laboratory Grade		
3A	No. 4	1	180	3880	...
3B	No. 4	1	160	3290	113
3C	No. 4	1	150	3130	...
Average			163	3430	...
3D	No. 4	7	130	2930	...
3E	No. 4	7	145	3190	94
3F	No. 4	7	150	2410	...
Average			141	2840	...
3G	No. 4	28	245	3310	...
3H	No. 4	28	290	3570	80
3I	No. 4	28	150	1250	...
Average			228	2700	...

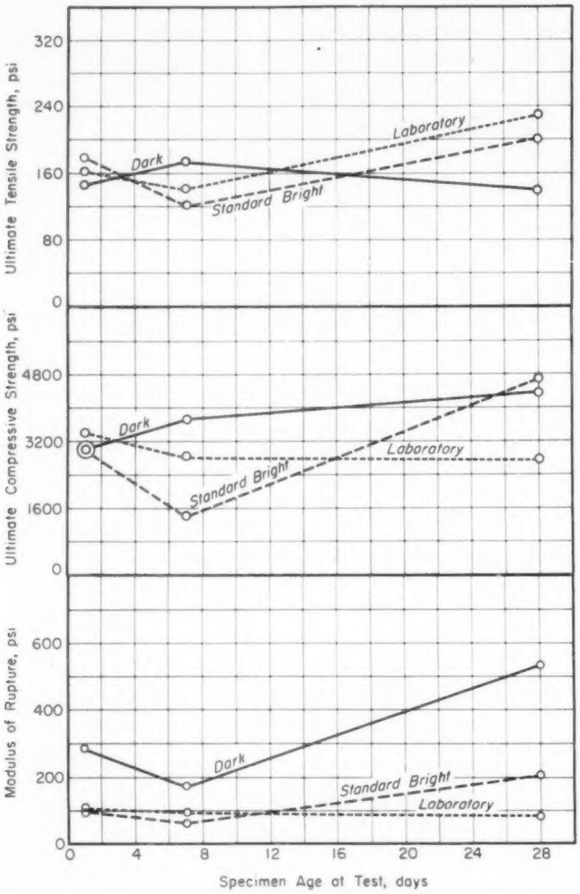


Fig. 7.—Effects of variations in grade and age on tensile strength, compressive strength, and modulus of rupture.

The impurities present in the dark and standard bright grades appear to increase the strength of the sulfur.

This study was entered into with no real feeling for what the mechanical properties of elemental sulfur might be or what effects the variations in grade and age might have on the material. The 1-, 7-, and 28-day testing schedule was chosen on an arbitrary basis. The mechanical properties of elemental sulfur show a tendency to increase with time. The final ultimate strength of elemental sulfur appears to occur at some time beyond the 28-day period.

Results obtained in this study have been very encouraging, as they have shown that elemental sulfur has tensile and compressive strengths slightly greater than conventional concrete, which has an ultimate tensile strength of about 150 psi and an ultimate compressive strength of about 3000 psi. Examination of the laboratory test data reveals that various specimens had strengths from 50 to 100 per cent greater than companion specimens. Reasons for the added strength of these specimens are not known, but they are significant in that determination of the conditions which created these added strengths might allow their reproduction.

Because of the small number of specimens prepared and tested in this study as compared to the extremely large number of variables and influencing factors, this can be considered only a very preliminary investigation of the mechanical properties of sulfur. This work has shown that elemental sulfur does have strength characteristics sufficient to qualify as a structural material. By selecting a combination of conditions, it is possible that the structrual properties of sulfur might be used to great advantage in new applications.

Acknowledgments:

The author wishes to acknowledge the assistance of the Freeport Sulphur Co., Jefferson Lake Sulphur Co., and Texas Gulf Sulphur Co., who each provided, free of charge, portions of the material used in these tests. Appreciation is due L. B. Jensen of Jefferson Lake Sulphur Co., G. T. McBride, Jr. of Texas Gulf Sulphur Co., and William N. Tuller of Freeport Sulphur Co., who offered their suggestions on the casting of specimens

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Determination of Gypsum and Its Dehydration Products in Their Mixtures

By H. G. McADIE and R. A. KUNTZE

A simple method is described for determining the proportions of each constituent in a mixture of calcium sulfate dihydrate, hemihydrate, and soluble anhydrite. The results of separate hydration and dehydration procedures, which are performed simultaneously on different portions of the sample, are applied to a triangular diagram based on the stoichiometry of the calcium sulfate–water system. The proportions of the three constituents are obtained directly from this diagram or from algebraic relations derived from it. For mixtures containing materials other than dihydrate, hemihydrate, and soluble anhydrite, a preliminary determination of the calcium sulfate and water present as these compounds is required. Impurities that change in weight below 225 C interfere with the method, and it is not applicable to finished plaster products containing accelerator, retarder, surface-active agents, etc., or to "aridized" calcination products. The method is intended for use primarily with mixtures of gypsum calcination products before these are formulated or further processed.

In studying the dehydration of calcium sulfate dihydrate (gypsum), it is often of interest to determine the proportions of the decomposition products—hemihydrate (plaster of Paris) and soluble anhydrite—present with undecomposed dihydrate. Such mixtures may be produced during the commercial dehydration of gypsum for plaster production, and a method for their analysis is useful in control of the final product. The present work is concerned with determining small quantities of dihydrate and soluble anhydrite in the presence of hemihydrate. Sedimentation methods (**1**)[1] have shown erratic results, and infrared, X-ray diffraction, and differential thermal analysis techniques were found to lack sensitivity.

A combination of hydration and dehydration processes was proposed by Scheer (**2**,**3**) for analysis of such mixtures. Two quantities are determined per gram of dry mixture: (1) the weight of combined water, and (2) the gain in weight after hydration of the soluble anhydrite to hemihydrate. These quantities are applied to a triangular diagram, from which the proportions of dihydrate, hemihydrate, and soluble anhydrite are interpolated. The present work makes use of a similar triangular diagram, or of simple algebraic relations derived therefrom, the method being modified and extended to deal with mixtures arising from both natural and synthetic gypsums and to reduce the time required from 3 days to less than 12 hr.

Experimental

The two quantities are determined simultaneously on different portions of the same mixture sample, it often being convenient to carry out both steps overnight. Before either step the bulk sample is dried to constant weight at 45 C, and should pass a 60-mesh screen.

The first step involves the hydration of soluble anhydrite in the original sample to the hemihydrate composition only. The original three-day equilibration of the sample with water vapor (**3**) has been replaced by hydration with aqueous ethanol, following a suggestion of the National Gypsum Co. (**4**), reducing the time required to less than 12 hr. Five-gram portions of the sample are spread in thin layers in low-form weighing bottles that can be stoppered. The sample is treated with 5 ml of 80 per cent (by volume) aqueous ethanol for 10 min, placed in an oven at 45 C, and dried to constant weight. The oven should have enclosed heating elements. Drying requires about 10 hr, but can be considerably accelerated by placing the oven under a partial vacuum (20 mm Hg) until the bulk of the residual liquid is removed. Differential thermal analysis of samples treated in this manner (**5**) confirmed that only hemihydrate is produced under these conditions.

It has been found possible to employ aqueous ethanol of 75 to 85 per cent (by volume) for the hydration step, while producing only hemihydrate. If it is not convenient to use undenatured ethanol, No. 30 specially denatured alcohol (85 ethanol, 10 methanol, 5 water) may be substituted and diluted to a total water content of 15 to 25 per cent (by volume).

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[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

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Combined water is obtained by dehydrating 2-g samples in an electric furnace, and cooling over phosphorus pentoxide before weighing. At 225 C this requires 5 to 8 hr, and the dehydrated residue must be weighed rapidly on removal from the desiccator. It is preferable to dehydrate at 450 C for 2 to 4 hr, provided no impurities are present which lose weight at this temperature. This produces a residue containing some insoluble anhydrite (6,7), which is advantageous in the final weighing, since soluble anhydrite is an excellent desiccant (8), while insoluble anhydrite does not appreciably adsorb water (9). A longer dehydration time results in a higher percentage of insoluble anhydrite in the sample (6).

Obviously, any impurity that undergoes a weight change below 225 C will interfere with the method. Finished plaster products containing organic materials such as retarders or surface-active agents, other inorganic crystallohydrates such as aluminum sulfate or calcium chloride, and certain types of clay that lose water below 225 C, are unsuitable to this method unless a correction can be made for weight changes due to these impurities. The presence of sand does not interfere.

For impure samples it is necessary to know the calcium sulfate and water present as dihydrate, hemihydrate, and soluble anhydrite. This calcium sulfate may be determined by hydrating a 5-g portion of the dry sample with 5 ml of water for 1 hr, followed by drying to constant weight at 45 C. A partially evacuated oven may again be used to remove the bulk of the residual liquid. The dihydrate thus produced is dehydrated at 225 or 450 C, and the calcium sulfate equivalent to the water loss is calculated. The combined water in the original sample is already known from the determination described earlier.

Insoluble anhydrite may be treated as an impurity in this method, since it is not affected either by the dehydration step or by the hydration in aqueous alcohol. If total calcium sulfate in the original sample is determined by conventional wet-chemical analysis, the difference between this value and the calcium sulfate present as dihydrate, hemihydrate, and soluble anhydrite will include any insoluble anhydrite present.

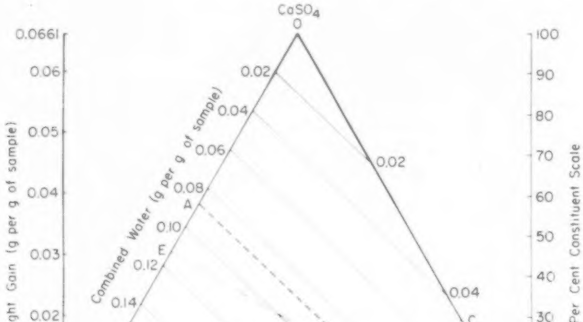

Fig. 1.—Nomogram used in determining the composition of hydrate mixtures (adapted from Scheer (3)).

Method of Calculation

The percentages of each constituent may be obtained by graphical interpolation from a triangular diagram, or from algebraic relations derived therefrom. Both methods will be described.

Graphical

Figure 1 is a weight-composition diagram based on the stoichiometry of the calcium sulfate–water system in which lines of equal combined water are plotted. The weight gain on hydration of soluble anhydrite to hemihydrate is represented by the left-hand vertical scale, which has been moved outside the triangle for clarity. This scale indicates that a gain of 0.0661 g per g sample on hydration in aqueous alcohol corresponds to a soluble anhydrite content of 100 per cent. It is implicit that the height of the triangle also corresponds to a system containing 100 per cent ($CaSO_4$ + H_2O) present as dihydrate, hemihydrate, and soluble anhydrite. From geometry, then, the perpendicular distances *CP*, *EP*, and *DP*, measured in terms of the height of the triangle, directly represent the percentages of dihydrate, hemihydrate, and soluble anhydrite, respectively. A scale for the conversion of the measured lengths of *CP*, *DP*, and *EP* into percentages is given at the right-hand side of the triangle.

In practice, Fig. 1 is reproduced on a suitably enlarged scale and the height of the triangle obtained becomes equivalent to 100 per cent; for example, a triangle 500 mm high would result in a 1-mm distance along *CP*, *DP*, or *EP* being equivalent to 0.2 per cent of the particular constituent.

With impure samples the experimental weight loss and gain values are corrected by an appropriate factor before application to Fig. 1. The dihydrate, hemihydrate, and soluble anhydrite composition obtained by measurements on Fig. 1 is then multiplied by the inverse of this factor to obtain the composition in the original sample. An example will illustrate these points.

Consider an impure sample containing dihydrate, hemihydrate, and soluble anhydrite, in addition to other materials which do not undergo weight change during the analytical techniques. Unless otherwise indicated, the following weights are given in grams per gram of dry sample:

m	=	calcium sulfate content by conventional analysis,
n	=	calcium sulfate content calculated from weight loss of sample hydrated by water,
$(m - n)$	=	calcium sulfate not hydrated by water,
w	=	combined water in mixture sample, and
h	=	weight gain on hydration by aqueous alcohol.

Thus:

$100\,(n + w)$	=	sample purity, per cent
$\frac{w}{(n + w)}$	=	combined water in mixture sample, corrected for sample purity (line *AP*, Fig. 1), and
$\frac{h}{(n + w)}$	=	weight gain on hydration by aqueous alcohol, corrected for sample purity (line *BP*, Fig. 1).

The weight of combined water per gram of dry sample corrected for the purity of the original sample, is located as line *AP* in Fig. 1. The weight gain per gram of dry sample after hydration of soluble anhydrite to hemihydrate, also corrected for the purity of the original sample, is located on the vertical scale and a horizontal line, *BP*, drawn to intersect the combined water line at point *P* within the triangle. The perpendicular distances *CP*, *DP*, and *EP*, measured from point *P* to the sides of the triangle, when applied to

the right-hand scale in Fig. 1, represent the percentages of dihydrate, soluble anhydrite, and hemihydrate, respectively, in a sample containing only these three constituents. The composition of the original impure sample is then given by:

% dihydrate $= (n + w) \times$ (% constituent equivalent to CP),

% hemihydrate $= (n + w) \times$ (% constituent equivalent to EP), and

% soluble anhydrite $= (n + w) \times$ (% constituent equivalent to DP.)

Algebraic

Consideration of the geometry of Fig. 1 leads to a set of simple algebraic relations for determining the percentages of each constituent. Using the same nomenclature as before,

% soluble anhydrite $= 1511.4\ h$,

% hemihydrate $= 679.39\ [0.20927\ (n + w) - (w + 3.1629\ h)]$, and

% dihydrate $= 100\ (n + w) -$ (% hemihydrate + % soluble anhydrite).

Results

The reliability of the hydration method for determining soluble anhydrite was tested with samples of synthetic soluble anhydrite prepared from reagent-grade dihydrate by dehydration at 115 C in air. Assuming any residual water to be present as hemihydrate, the soluble anhydrite content was calculated from the weight loss on total dehydration at 450 C. Other portions of the same sample were hydrated with 80 per cent ethanol and the soluble anhydrite content calculated from the weight gain. The results in Table I indicate that the hydration of soluble anhydrite is about 99.75 per cent complete by this method.

The over-all method was evaluated in two ways. In the first, reagent-grade dihydrate was dehydrated for various times at about 120 C in air with continuous stirring. The resulting mixtures were analyzed for their hydrate composition. From this hydrate composition the percentages of calcium, sulfate, and water in each sample were calculated and compared with the values obtained by direct wet-chemical analysis (see Table II). The experimentally determined hydrate composition was found to reproduce the actual elemental analysis reasonably well.

TABLE I.—THE DETERMINATION OF SOLUBLE ANHYDRITE BY HYDRATION AND DEHYDRATION METHODS.

Sample	Dehydration at 450 C: Water Lost, Per Cent	Dehydration at 450 C: Calculated Soluble Anhydrite, Per Cent	Hydration in 80 Per Cent Ethanol: Water Gain, Per Cent	Hydration in 80 Per Cent Ethanol: Calculated Soluble Anhydrite, Per Cent	Difference, Per Cent
A	0.472	92.39	6.091	92.03	−0.36
B	0.480	92.27	6.088	91.99	−0.28
C	0.495	92.02	6.085	91.95	−0.07

TABLE II.—THE COMPOSITION OF DEHYDRATED SYNTHETIC GYPSUM.

Sample	Composition Found: $CaSO_4 \cdot 2H_2O$, Per Cent	Composition Found: $CaSO_4 \cdot {}^1/_2H_2O$, Per Cent	Composition Found: Soluble, $CaSO_4$, Per Cent	Calculated from Composition Found: Calcium, Per Cent	Calculated from Composition Found: Sulfate, Per Cent	Calculated from Composition Found: Water, Per Cent	Found by Direct Analysis: Calcium, Per Cent	Found by Direct Analysis: Sulfate, Per Cent	Found by Direct Analysis: Water, Per Cent
A	8.05	88.54	3.41	27.33	65.49	7.18	27.36	65.59	7.18
B	6.95	91.32	1.73	27.34	65.54	7.12	27.34	65.54	7.12
C	0.40	83.09	16.51	27.89	66.86	5.25	27.83	67.01	5.24
D	0.02	99.97	0.01	27.61	66.18	6.21	27.64	66.25	6.21

TABLE III.—DETERMINATION OF DIHYDRATE IN MIXTURES.

Sample	Dihydrate Added, Per Cent	Total Calcium Sulfate plus Water, Per Cent	Total Dihydrate Found, Per Cent	Added Dihydrate Found, Per Cent	Difference, Per Cent
Plaster of Paris	0.00	85.53	2.99[a]	...	...
Mixture A	1.08	85.69	4.28	1.29	+0.21
Mixture B	1.97	85.82	4.84	1.85	−0.12
Mixture C	2.95	85.96	5.74	2.75	−0.20
Mixture D	3.82	86.08	6.89	3.90	+0.08
Mixture E	4.82	86.23	7.55	4.56	−0.26
Mixture F	5.83	86.37	8.82	5.83	0.00

[a] Average of three determinations.

A second test of the method was made by adding known quantities of reagent-grade dihydrate to an impure commercial plaster of Paris and determining the resulting hydrate composition. The results, given in Table III, show a reasonable agreement between the percentages of dihydrate added to the plaster and those found. The tendency is toward somewhat low results.

Conclusion

A simple and reasonably accurate method has been presented for the determination of calcium sulfate dihydrate, hemihydrate, and soluble anhydrite in their mixtures. The method is applicable to mixtures of dehydration products from both natural and synthetic gypsums, provided impurities that change in weight below 225 C are absent.

Acknowledgment:

The authors wish to thank Gypsum, Lime and Alabastine, Ltd., for support of this work and for permission to publish the results obtained.

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Technical Note

Detection of Glycols in Crankcase Oils

There are cases where seepage of glycol coolants into the crankcase of an internal combustion engine may cause complete seizure of the engine. Because of this, detection of vicinal glycols in crankcase fluid is often desirable.

The periodate test[1] does not work on water extractions from crankcase fluids as removed from a seized engine. This otherwise sensitive test appears to be masked by reaction products or additives.

It is possible by the use of an adaption of the standard azeotropic reflux distillation procedure,[2] using a modified Dean and Stark apparatus,[3] to recover the vicinal glycol for identification by the periodate test. While no extensive tests have been conducted on establishing the concentration that will cause seizure of a motor, it is believed that this procedure would be reliable for concentrations as low as 1 per cent.

Procedure

Place about 100 ml of the oil to be tested into a 500-ml round-bottomed flask with sidearm. Add 50 ml of xylene and a few boiling chips. Insert a thermometer into the arm of the flask so that the bulb is immersed in the oil. Attach the reflux distillation apparatus. Raise the temperature slowly but steadily by a suitable heat source until boiling begins, and adjust to a slow steady boil. When the trap becomes filled with xylene, add water through the condenser into the trap at the rate of approximately 10 drops per min. When the water (bottom layer) fills the trap to the 15-ml mark, withdraw the water layer.

Place 4 to 5 ml of 0.04 *N* periodic acid in a test tube; add 3 to 4 drops of concentrated nitric acid (spgr 1.42) and shake. Add 2 to 3 ml of 0.1 *N* silver nitrate. Add 5 ml of the water sample and shake thoroughly. The formation of a dense white precipitate (Silver iodate, $AgIO_3$) within 30 sec indicates vicinal glycol.

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[1] L. Malaprade, "Oxidation of Some Polyalcohols by Periodic Acid-Applications," *Comptes Rendus* (Academie des Sciences, Paris) Vol. 186, p. 382 (1928).
[2] ASTM Method of Test for Water in Petroleum Products and Other Bituminous Materials, 1958 Book of ASTM Standards, Part 4, p. 1079; Part 7, p. 42; Part 8, p. 219.
[3] E. W. Dean and D. D. Stark, "A Convenient Method for the Determination of Water in Petroleum and Other Organic Emulsions," *Industrial and Engineering Chemistry*, Vol. 12, pp. 486–490 (1920).

Use of the Stormer Viscometer for Testing Rotogravure and Flexographic Inks*

By R. CUMMINGS

Inks for printing by the rotogravure and flexographic processes are fluid systems composed of pigment, resin, and volatile solvent. Their consistency is frequently determined by efflux instruments such as the Zahn cup, but because of the high degree of thixotropy sometimes possessed by the inks, the cup does not drain completely and the time observed is incorrect. Also, because of the very volatile solvents used in these inks, they may evaporate so rapidly that the orifice is restricted and there is interference with free flow.

The ASTM Method of Test for Consistency of Exterior House Paints and Enamel Type Paints (D 562–55)[1] may be used for these inks with good success, but two objections appear: the size of the sample required (1 pt) is uneconomical, and flexographic inks usually contain shellac solutions which react with the tin can used in the standard method, resulting in discoloration of the ink.

Changes in Apparatus

We have therefore made a new paddle-type rotor, shown in Fig. 1, that will operate in a 4-oz, wide-mouth glass bottle 2 in. in diameter by $3\frac{3}{8}$ in. tall,[2] which are the bottles used for storing samples.

To rotate this paddle at 200 rpm requires a smaller weight than in the standard test, so a weight holder and weights were made which permit rapid handling. These are shown in Fig. 2. The weight holder weighs 10 g and the weights are 1, 2, 3, 4, 5, 10, 20, 30, 40, and 50 g. Purchased hook weights of 100, 200, and 500 g are sometimes used.

Procedure

The procedure followed in making measurements is similar to Procedure B of ASTM Standard Method D 562. A Stormer viscometer with stroboscopic timer is used with the special weight holder and paddle-type rotor. The sample in a 4-oz, wide-mouth glass bottle is shaken on a paint conditioner for 2 min and brought to a temperature of 25 ± 0.2 C, and so maintained during the test. The container is set on the

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NOTE—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author or authors. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

* Presented at the Third Pacific Area National Meeting, San Francisco, Calif., Oct. 11–16, 1959.
[1] 1958 Book of ASTM Standards, Part 8, p. 704.
[2] Owens-Illinois Glass Co., 2978-C.

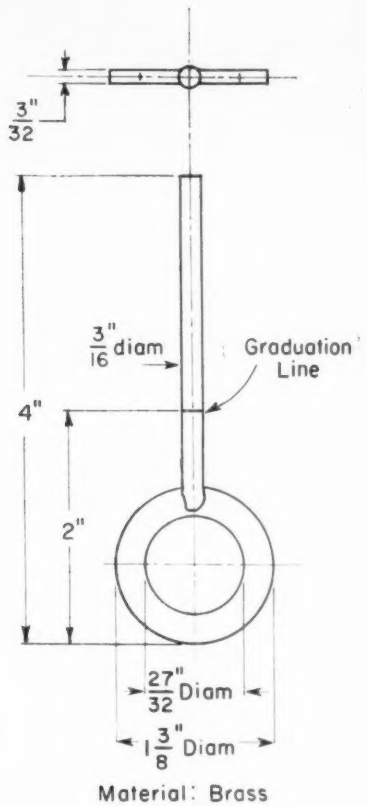

Fig. 1.—Paddle-type rotor.

stand of the instrument, which is raised to bring the surface of the sample to the mark on the paddle shaft. Weight is added which will produce a pattern indicating a speed greater than 200 rpm and allowed to descend once to stir the sample and reduce thixotropy. As quickly as possible, weights are changed, and the weight, to the nearest gram, that will produce and maintain the 200-rpm pattern is found. This weight in grams is reported as the consistency.

Rotogravure and flexographic inks may show a consistency as high as 200 g but usually are sold in the range of 50 to 60 g.

For lithographic varnishes conversion from Stormer grams to poises can be made by the equation

$$\text{Poises} = \frac{(\text{Stormer grams} - 20)}{18}$$

The procedure described has been in use for five years at the Berkeley factory and at branches of The California Ink Co., Inc., and has been found satisfactory.

Advantages

Compared to efflux instruments, the Stormer viscometer with modification described here is faster, easier to clean, and does not produce doubtful results if the sample is thixotropic. Compared to ASTM Standard Method D 522, it permits use of a smaller sample and a container more suitable for the material. The rotor is simpler in shape, which permits easier cleaning with a cloth. It is stronger and resists damage by rough handling. It is also easy to make duplicate rotors which check each other closely in performance.

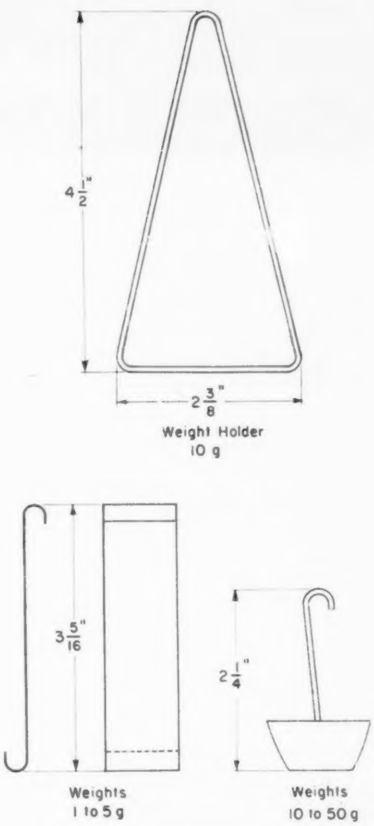

Fig. 2.—Weight holder and weights.

Why Soil Dynamics?

By R. K. Bernhard[1]

The scientific approach to a study of soils as an indispensable engineering material represents a rather new topic, and its subdivision into soil statics and soil dynamics is of still newer origin.

In attempting to answer the question, "why soil dynamics?" it might be useful to recall the history of testing materials other than soil. The study of steel specimens subjected to slowly increasing static loads was followed by the introduction of vibratory or dynamic loads, which led to the discovery of fatigue effects. A cross fertilization of both methods took place, contributing to a new concept in instrumentation, and recently expanding into the field of solid-state physics. Similarly, the investigation of soil dynamics will feed information back into soil statics and result in a better understanding of both areas.

From the practicing engineer's point of view, the impetus to study soil dynamics is due mainly to the increased speeds and loads of present-day vehicles affecting highway subsoils and also to the practice of dynamic pre-compaction of subsoils.

From the more theoretical point of view, a determination of basic dynamic soil values, such as modulus of elasticity, energy dissipation, and resonance phenomena, are of fundamental importance. Both the practicing engineer and the theoretician have a stake in answering the difficult question: Can we develop a mathematical model or dynamic analogy that will enable us to predict the behavior of soils subjected to vibratory loads? Much can be learned from the geophysicists, although they deal with large distances (macroseismic problems), whereas the engineer is, comparatively speaking, concerned with phenomena in the vicinity of the disturbing source (microseismic problems).

Of some 25 problems on needed research suggested by the Research Steering Subcommittee of Committee D-18 on Soils for Engineering Purposes, almost 25 per cent fall within the realm of soil dynamics. A host of questions can be raised. For example, what frequency is considered the transition point between slow vibratory loads (dynamic-steady and secular, with acceleration effects predominant) and still slower loads (static-repetitive, with weight effects governing), and at what distance between disturbing source and its response in the soil does seismology begin?

It is hoped that some discussion of this new science might emanate from this brief note. A Symposium on Dynamic Properties of Soils will be sponsored by Committee D-18 at the 1961 Annual Meeting. This is the second symposium on the subject, the first having been published as *STP 156*.

[1] Rutgers Univ., New Brunswick, N. J.

COMMENT

Bulletin, 40, Now a Monthly

WITH THIS ISSUE, three months shy of the age at which life is reputed to begin, the ASTM BULLETIN, under a new name, becomes a monthly publication.

Since the first issue of the BULLETIN, in April, 1921, the world has moved fast and far. The four-page publication, to be issued at "approximately quarterly intervals," first saw the light of day in the same year that Albert Einstein received the Nobel Prize in physics for his explanation of the photoelectric effect. This was also the first full year of operation for the nation's first commercial radio broadcasting station, Westinghouse's KDKA, in Pittsburgh. The ASTM Annual Meeting that year was held in Asbury Park, N. J. An announcement in the BULLETIN told the Society's 3000 members that American Plan rates were available at the New Monterey Hotel for rooms with bath, rooms with running water, and rooms *without* running water. This, alone, is a measure of our progress since 1921.

Five years later, in April, 1926, the BULLETIN, still a quarterly, but grown to 12 pages, adopted a cover and began to carry advertising. The charter advertisers: Tinius Olsen Testing Machine Co., Riehle Brothers Testing Machine Co., Scott Testers, Westinghouse Technical Night School Press, Pittsburgh Instrument and Machine Co., Robert W. Hunt Co., Fr. Fleischhauer & Son, Philadelphia Thermometer Co., Eimer & Amend, United States Testing Co., Inc., Central Scientific Co., Pittsburgh Testing Laboratory, and Herman A. Holtz.[1] This issue announced special railroad rates for those journeying to the Annual Meeting in Atlantic City, which would apply to "points where the railroad fare is more than 67 cents." Elsewhere in the world of transportation, plans were being announced for construction of the George Washington Bridge to connect New Jersey to Manhattan, across the Hudson River. The first successful trans-Atlantic radio telephone conversation was held that year, between New York and London. And Richard E. Byrd and Floyd Bennett became the first humans to fly over the North Pole

The year 1927 saw Arthur Compton awarded the Nobel Prize in physics for his discovery of the Compton effect. In this year, the BULLETIN became a bimonthly and adopted a new cover, with color. This year also witnessed the first successful demonstration of television, the invention of the "iron lung," and the opening of the Holland Tunnel.

BULLETIN No. 66, dated January 31, 1934, was the first to carry technical papers. Now grown to 20 pages, the magazine took on a new cover design. 1934 was the year in which Harold Urey received the Nobel Prize in chemistry for his discovery of heavy hydrogen; duPont chemist Wallace H. Carothers spun the first fiber of nylon; and an electric clock manufacturer in Chicago, Laurens Hammond, produced the first electric organ.

By 1940, the year the Tacoma Narrows suspension bridge collapsed and fell 190 feet into Puget Sound, the BULLETIN, still a bi-monthly, had grown to 64 pages, and adopted the cover design that is replaced with this issue. In this same year, RCA developed the first electron microscope, and the first successful helicopter flight in the United States took place.

In July, 1949, BULLETIN No. 159 became the first to be issued on an 8-times-per-year basis. Also in 1949, the WAC-Corporal became the first man-made object ever to soar as high as 250 miles above the earth. Cortisone was discovered that year, and the B-29 *Lucky Lady II* made the first non-stop round-the-world flight.

So much for the past 40 years. What about the next 40? One is tempted to set up the proportion: first radio broadcast is to Echo satellite as Echo satellite is to X. But who among us would have the audacity to solve for X?

A.Q.M.

[1] Then U.S. agent for Amsler and Co.

Program Announced for 1961 Temperature Symposium

At the most comprehensive meeting ever held on the subject, about 200 papers will cover temperature measurements from absolute zero to 10,000,000 K. Almost every area of the physical, biological, and medical sciences will be represented at the 1961 Symposium on Temperature, Its Measurement and Control in Science and Industry, to be held in Columbus, Ohio, March 27–31, 1961. The conference is sponsored by the American Institute of Physics, the Instrument Society of America, and the National Bureau of Standards.

The 200 papers scheduled for presentation come from universities, government and military research laboratories, and industrial research laboratories in this country, as well as from research centers in Australia, Germany, Netherlands, Canada, Soviet Russia, and Great Britain.

Some of the most recent advances in high- and low-temperature measurements will be described. Interest in the higher regions is sparked by the great efforts being made in plasma physics. At the lower end of the scale, there is great interest in extending the International Practical Temperature Scale down to the region of 1 K.

On the arrangements committee, as representatives of ASTM Committee E-1 on Methods of Testing, are R. D. Thompson, Taylor Instrument Cos. and A. I. Dahl, General Electric Co.

Persons interested in the symposium may obtain further information from V. W. Sikora, Instrument Society of America, 313 Sixth Avenue, Pittsburgh 22, Pa.

First Corrosion Congress To Meet in London

The First International Congress on Metallic Corrosion will be held under the auspices of the International Union of Pure and Applied Chemistry in London, April 10–15, 1961. The organizing committee intends to devote much of the congress to discussion of papers dealing with original work, but first-class, up-to-date review papers will also be included.

ASTM Past-President F. L. LaQue and Honorary Member F. N. Speller are honorary vice-chairman of the congress.

Preprints will be issued well before the congress, and authors will be invited to introduce their papers briefly for discussion at the meetings. All papers, together with discussion, will be published subsequently as the Proceedings of the congress.

Additional information is available from The Hon. Secretary, First International Congress on Metallic Corrosion: London, 1961, 14 Belgrave Square, London, S.W.1.

Forest Products Group Sets 1961 Annual Convention

The Forest Products Research Society will hold its 1961 Annual Convention in Louisville, Ky,. June 18–22, 1961, at the Kentucky Hotel.

The 4000-member society was founded in 1947 to encourage and promote the fullest and most efficient use of wood and other forest products.

The 1961 Convention is under the auspices of the Ohio Valley Section. Mr. Carl Trinkle, of the Baldwin Piano Co., Cincinnati, Ohio, is the general chairman.

Vacuum Technology Conference

The American Vacuum Society will be host to the International Organization for Vacuum Science and Technology for the Second International Vacuum Congress to be held October 16–19, 1961, in Washington, D. C., at the Sheraton-Park Hotel. Papers are invited on all phases of vacuum technology including generation, measurement, and application in research and industry. Abstracts should be submitted by April 15, 1961, addressed to L. E. Preuss, chairman of the Scientific Program Committee, Edsel B. Ford Institute for Medical Research, Detroit 2, Mich.

Electron Microscope Society Annual Meeting Set for August

The 19th Annual Meeting of the Electron Microscope Society of America will be held Aug. 23–26, 1961, in the Pittsburgh Hilton Hotel, Pittsburgh, Pa.

In addition to the general sessions of contributed papers, it is planned to hold a special session of short papers on interesting, useful, and unusual electron microscopic techniques. Abstracts of all contributed papers for presentation at the technical sessions may be submitted to the program chairman, A. R. Taylor, Research Div., Parke, Davis and Co., Detroit 32, Mich., before May 1, 1961.

Translations of Russian Journals Available to ASTM Members

Publication of translation editions of the major Russian journals in the field of engineering materials will be sponsored by *Acta Metallurgica*, an international fundamental journal in the materials field. Titles of Russian journals now available are:

The Physics of Metals and Metallography USSR
The Journal of Abstracts—Metallurgy (Part A) Science of Metals
The Journal of Abstracts—Metallurgy (Part B) Technology of Metals
Metal Science and Heat Treatment of Metals
Refractories
Metallurgist

Through the aid of a grant from the National Science Foundation, subscriptions can be offered at greatly reduced rates to individual members of sponsoring and cooperating societies of *Acta Metallurgica*. Since ASTM is a cooperating society, its members can take advantage of this offer. For further information write: Business Manager, *Acta Metallurgica*, 122 E. 55th St., New York 22, N. Y.

Recent Developments in Europe[1]

New developments pointing to greater use of IEC and ISO procedures will be of special interest to U. S. industry concerned with international trade. The national standards organizations of the European Common Market countries and the European Free Trade Association[2] have taken action to coordinate their national standards and eliminate differing standards that may hinder trade and nullify or reduce the benefits of lower tariff barriers. The European Common Market countries had already taken measures to accept recommendations of the International Organization for Standardization and the International Electrotechnical Commission. The present move extends this collaboration to both groups.

Joint committees are being set up to deal with electrical subjects (handled by IEC and CEE[3]), and nonelectrical subjects (handled by ISO). The Association Francaise de Normalisation, the French national standardizing body, has been assigned the secretariat for these joint committees. The work will be kept as far as possible within the framework of ISO, IEC, and CEE, the British Standards Institution reports, since this is not an attempt to create new international standards or recommendations on a regional basis.

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[1] From *The Magazine of Standards*, October, 1960.

[2] The European Common Market countries (known popularly as the Inner Six): France, West Germany, Italy, Belgium, Luxembourg, Netherlands; the European Free Trade Association (known popularly as the Outer Seven): Austria, Denmark, Norway, Portugal, Sweden, Switzerland, United Kingdom.

[3] CEE—International Commission on Rules for the Approval of Electrical Equipment.

MR&S FEATURE

ASTM - The Materials Society

1960 Record of Achievement

At year's end it is traditional to look back, to reflect on progress made, partly to take pride in accomplishments but also to find a guide for the future. One useful yardstick for accomplishment is a general statement of purposes or objectives, but even more importantly, one must also consider the trends of the times. Is the Society meeting its responsibilities in a changing world, not only to its members but to all the scientific and technical community, indeed the whole nation and beyond? In this annual review—an inventory of progress and achievement—these yardsticks: purposes, trends of the times, responsibilities, are the measures for evaluating the Society's expanding organization, its growing technical program, and its ever-increasing stock of standards for materials.

Measures of Progress

The two-fold objectives of the Society—to promote knowledge of materials of engineering and to standardize specifications and tests—provide the basic measure. Growing out of this and in the light of changing times is the realization that the Society must continue to examine its means for meeting its objectives if it is to serve its purpose properly as a materials Society.

The Society's most important activity is standardization. ASTM standards, known throughout the world and the "bible of materials" in this country, are the best that our technology can make them—right now, that is. But if the new science of materials and the new technology are to be properly applied in materials standards, many, if not most, standards for materials will change their complexion in coming years. Prediction of properties based on structure is a reality in many instances, and ability to do this will increase with our fundamental knowledge. This will enable the Society to develop standards which depend less on empiricism than they do on basic principles.

Divison of Materials Sciences

The Board of Directors, recognizing the need for a broad approach in promoting the science of materials in the Society, authorized the establishment of a Division of Materials Sciences early in 1959. During 1960, the division was formally organized. Its scope—a broad concern with the nature and origin of basic properties of materials, the relation of properties to structure, and promotion of knowledge of the fundamental nature of materials—gives it plenty of room to operate. But its policies will be guided by a council representing the technical committees, thus assuring that the course of the division's activities will always mesh with the main objectives of the Society in developing standards.

Properties of Crystalline Solids

The first public effort of the division was to sponsor two symposia, on Progress in Materials Sciences and on Nature of Strength Properties, the papers from which are being published by the Society under the title "Properties of Crystalline Solids." These symposia, while they skim lightly over a very broad field of materials sciences, may point the way for the division in periodically providing for reviews or state-of-the-art monographs understandable to a broad spectrum of technical people represented in the Society as members and serving on the technical committees.

Plans are going forward for similar broad-subject symposia at future meetings. For the 1961 Annual Meeting, a Symposium on Effects of Trace Elements on Properties of High Purity Materials is shaping up.

New Look in Tune with the Times

As if graphically to show that the Society is moving forward on all fronts, this magazine blossoms forth with this issue under a new title and format. Also in this issue is the third of a regular series of columns under the heading *Materials Sciences*, initiated in the October, 1960, issue.

New Committees Organized

More than the usual number of new committees were organized during 1960—five, in all. Four of the five are on general subjects, that is, they are E-committees, with interests cutting across those of other committees of the Society.

Ore Sampling and Analysis.—Committee E-16 on this subject, formally organized last June, is concerned with sampling, analysis, and testing of natural and processed metal-bearing ores and related raw materials, such as fluxes.

Skid Resistance.—Committee E-17 on this subject was organized during the 1960 Annual Meeting. It will be concerned with problems of evaluating traffic surface slipperiness.

Sensory Evaluation.—The new Committee E-18 on Sensory Evaluation of Materials and Products, organized in October, will, for the first time, bring to bear on ASTM problems a discipline from the social sciences—psychology—in cooperation with other interests to promote knowledge and to stimulate research on, and development of, principles and recommended practices for sensory evaluation of materials and products. The committee will attempt to standardize or to establish base lines for standardization of objective means of measuring many properties which are subjective in nature and which can only partly be correlated with objective measurements.

Gas Chromatography.—Committee E-19 on Gas Chromatography will be organized early next month. This technique capable of very fine separation and analysis of minute quantities of materials has been likened to a distillation column with an infinite number of plates. Wide interest has been shown in this proposed new activity.

Electronic Ceramics.—Committee C-25 on Ceramics for Electronics was organized in April, 1960, and held its first full-scale meeting in September. Initiative for organizing the committee came from the American Ceramics Society, with whose Electronics Division the new committee is closely affiliated. The committee will be concerned with the properties of low-loss dielectric ceramics, ferroelectric and nonmetallic materials, and ceramic-type semiconductors and composites.

Several other new activities have been inaugurated in existing technical committees. Especially worth mentioning is the project to develop specifications for heavy water for nuclear applications in Committee D-19 on Industrial Water and a project to develop standards for graphite for nuclear use in Committee C-21 on Ceramic Whitewares.

National Meetings

The Society held two national meetings during the year—Committee Week in Chicago in February and the Annual Meeting in Atlantic City in late June. Outstanding events at the Annual Meeting included two symposia related to materials sciences, mentioned above, the lecture on solar energy by Farrington Daniels, honoring the Society's first secretary, Edgar Marburg, the Gillett Lecture on nuclear fuel development by R. C. Dalzell, a number of technical sessions and symposia covering a wide range of the Society's across-the-board interests in materials, and an exhibit of apparatus and testing equipment. Among the subjects and materials covered at symposia and technical sessions were concrete, high-temperature properties of metals, fatigue, cement and plaster, shear and torsion testing, radiation effects, soils, and quality of observations. The papers in these sessions and symposia, most of which are being published by the Society, describe research on materials and tests directed toward a better understanding of properties and means for characterizing them.

Districts

The Society's district program in 1960 showed numerous signs of vigor and growth. A complete revision of the Charter and Manual for District Operation was begun, to give the district councils greater flexibility of action and to enable the districts to take a more active role in Society affairs.

The number of ASTM districts increased to 18 with the organization of the Northwest District, to serve members in Oregon, Washington, Idaho, and British Columbia. Except for four Central Plains States and part of Kansas, the entire continental United States is now served by district councils.

The past year also saw a growing trend toward more ambitious district meetings, often full-day programs, often including a complete symposium. Examples are the automation symposium held by the New England District, the joint Rocky Mountain District–ACI session on concrete research, and the all-day program in New England on materials in the jet-atomic age. The Central New York District has also been at the forefront of this trend.

Publications

An increasing proportion of the Society's total output of publications is appearing as monographs called special technical publications. Most of the papers presented at the Third Pacific Area National Meeting in October, 1959, were published as STP's during 1960. Subjects covered were:

Hydraulic Fluids (STP 267)
Soils (STP 254)
Admixtures in Concrete (STP 266)
Spectroscopy (STP 269)
Structural Sandwich Constructions (STP 270)
Newer Metals (STP 272)
Fatigue of Aircraft Structures (STP 274)
Air Pollution (STP 281)
Materials in Nuclear Applications (STP 276)
Nondestructive Testing in the Missile Industry (STP 278)
Waterproofing and Roofing Materials (STP 280)
Treated Wood for Marine Use (STP 275)
Road and Paving Materials (STP 277)
Applied Radiation (STP 268)
Testing Building Constructions (STP 282)
Industrial Water (STP 273)
Adhesives (STP 271)
Plastics for Rockets and Aircraft (STP 279)

Besides these, a number of papers from the Annual Meeting last June are being published as STP's. What is in prospect along these lines was described in the October, 1960, ASTM BULLETIN.

Standards.—The most recent accounting of standards approved by the Society for publication appears in the Annual Report of the Administrative Committee on Standards for the year 1959–1960, to appear shortly in the 1960 ASTM *Proceedings*. A numerical summary, for the year ending with the 1960 Annual Meeting, is as follows:

New tentatives	128
New standards	73
Revisions	341
Withdrawals	19
Total actions	561

In order to put these figures in perspective, the total number of ASTM standards and tentatives as of December, 1959, was

Standards	1510
Tentatives	1135
Total	2645

So, in one year, approximately 20 per cent of all the standards published by the Society were new or changed from the previous year. This is concrete evidence of the dynamic nature of materials standardization. Each of these changes or innovations may be expected to fill an industry need and to be in response to progress of the technology in the area covered.

In the following pages is presented a capsule view of individual standardization projects going on in the Society's technical committees. More on these projects may be found in the 1960 ASTM *Proceedings* to be available this spring and in every issue of the ASTM BULLETIN for 1960 under the heading of *Technical Committee Notes*.

Progress in Standardization

Polymeric Materials

Plastics

Major trends in plastics standardization during the year were in the direction of new materials and plastics products. Industry developments in polypropylene and other polyolefins, together with the well-established plastic, polyethylene, have resulted in the organization of a separate subcommittee on polyolefins in Committee D-20 on Plastics. Also, recognizing the growing need for standards for plastic shapes and products, the committee agreed to extend its activities in this area, based upon specific requests and indicated needs. Along these lines, the work on plastic pipe has been extended to include drain and sewer pipe, as well as electrical conduit. A new subgroup to develop standards for blow-molded plastics has also been established.

New test methods for plastics continue to flow from the committee to satisfy needs for measuring properties not previously covered by standard tests, such as, for example, resistance of plastics to sulfide staining (D 1712); or new angles on old tests, for example, tensile properties of microspecimens (D 1708), or impact resistance of fi.. by falling dart (D 1709). Also, the committee established, for the first time, a method for evaluating welding performance for PVC structures (D 1789).

The committee has developed a number of new specifications, not only for products, such as PVC pipe (D 1785), but for the compounds used to make the pipe, rigid PVC compounds (D 1784); and going still further back in the family tree of plastics and polymers,

specifications for TDI[1] and POPG[1]—raw materials used in the manufacture of isocyanate plastics and foams (D 1786).

Space-age applications of plastics are also the subject of a number of projects of the plastics committee. Under active development are test methods for ablation resistance of plastics for re-entry vehicles and for rocket nozzle applications. Other applications of reinforced plastics in missiles, space vehicles, and rockets are the subjects of standardization projects, symposia, or technical sessions.

Leather

Leather is one of the most durable and satisfactory materials for automotive upholstery, but consumers are chagrined if the part of the seat exposed to direct sunlight fades. So that both the producers and users of this type of leather will be able to determine the fading characteristics of colored leathers, the Joint Committee on Leather (with American Leather Chemists' Assn.) has completed an extensive program to develop a laboratory fading test for leather, with correlation with outdoor exposure. The program used 13 different leather samples to compare outdoor exposure in Florida with exposure to several types of laboratory radiant-energy sources. Data obtained are the basis for the establishment of a standard fading test method now being prepared by the committee.

The leather committee is endeavoring to establish objective measurements of comfort for leather as used in clothing. It hopes to correlate certain properties such as moisture transpiration characteristics with comfort, but establishing the correlation and measuring its degree is a major problem. The committee is hoping to get some help in this area from the new Committee E-18 on Sensory Evaluation of Materials and Products, with which it has established liaison.

Paper and Paper Products

The vital role that conditioning of paper plays in the results of physical tests for paper has long been recognized. Committee D-6 recently sponsored a symposium on conditioning, jointly with TAPPI, which will form the basis for improving the conditioning requirements of paper test methods.

Review of sampling techniques will lead to revisions of sampling method for paper (D 585). New methods being developed include colorimetric determination of starch, tests for mineral fillers and coatings, and methods to determine mold or mildew resistance.

[1] Toluenediisocyanate, polyoxypropyleneglycol.

Adhesives

Committee D-14 work on lumber adhesives includes preparation of wood surfaces for gluing, estimation of wood failure, and revisions in the requirements for the maple blocks used in Method D 905.

Metal-bonding adhesive tests under consideration include a room-temperature lap-shear method, a spring-type compression creep test, a high-temperature strength test, fatigue, inspection, and quality control methods.

Tests for adhesives for plastics, shoe soles, optical components, packaging, and general-purpose applications are being developed.

New strength tests include the T-peel test, a tensile-shear test using butt-type specimens, a disk-shear method, a dead-weight-loading creep test, an impact strength test, and a torsional shear method.

A method to measure the slippage and flow of adhesives in metal-to-nonmetal applications (such as in brake linings) has been completed.

Three methods of testing flooring adhesives have been prepared, and a method for preparing concrete slabs for use as test substrates is being discussed.

Cellulose and Cellulose Derivatives

To the cellulose acetate method (D 871) Committee D-23 will add five additional tests to characterize the material: heat stability, combined sulfur, hydroxyl content, intrinsic viscosity, and color and haze. These are ready for publication.

Methods being developed for refined cellulose include the measurement of whiteness by the spectrophotometer and a determination of ash and constituents of ash. Several methods to determine the functional groups of cellulose are in use: data from these methods are being evaluated to determine whether any one is superior to the others for development as a standard method. Chromatographic analyses of purified pulps have been cooperatively reviewed by the committee using portions of the standard samples set up two years ago. The resulting data are being used to form the basis of new method.

Casein and Similar Protein Materials

In an interlaboratory study, two caseins of widely differing viscosities are being studied by Committee D-25, using five standard instruments. The objective is to discover which apparatus will determine the viscosity of caseins most reproducibly.

A broad series of methods for casein and isolated protein are being developed, including tests for fat, foam, dirt content, ether extraction, insolubles, minimum alkali, and odor. Tests for casein and isolated soy protein used in paper coatings are also being studied.

Rubber

Many types of coated fabrics are used today for automobile parts and finishes. These products, which include boots, coated clips, coated sponge parts, and coated fabrics, are now covered by new Specifications D 1764. Another important specification covers carbon blacks used in rubber products (D 1765). This includes properties of blacks when incorporated in rubber and also certain properties of the carbon blacks themselves. A new practical test for solubility for organic chemicals (D 1766) is designed primarily for such materials used in rubber products. The comprehensive set of methods for chemical analysis of rubber products (D 297) was extensively revised and brought up to date. A definition of rubber was completed and published in D 1566. Further revision is being made of this definition, together with a definition for "rubber-like." Committee D-11 is very much interested in the effects of nuclear radiation on rubber. Two papers describing studies made in this area were presented at the June meeting of the committee.

Textiles

A set of methods for testing "two-way stretch" materials is embodied in the new methods of testing elastic fabrics (D 1775). Measuring the thickness of the textile material presents some difficulties owing to the soft or pliable nature of the material. A contribution in this area is a new method for measuring thickness of all types of knit, woven, and nonwoven textile materials (D 1777). A general method for conditioning textile materials for testing (D 1776) has also been completed. Two important new wool methods cover a procedure for determining neps in wool top (D 1770) and a method for sample reweighing of lots of packaged raw wool (D 1771). Tufted rugs and carpets are now being widely used, and for these materials there was issued a new test for colorfastness to commercial laundering and to domestic washing (D 1778).

Committee D-13 on Textiles took an active part in the plenary session of ISO/TC 38 on Textiles held in London, May 19–28. A delegation of 15 American representatives attended this meeting. Committee D-13 assumes a major part of the responsibility of the U. S. textile industry in establishing international standards for textiles.

Metals

Ferrous Metals

Committee A-1 continues to work closely with the ASME Boiler and Pressure Vessels Committee so that specifi-

cations for steels that are referenced in the Boiler and Pressure Vessel Code will reflect the experience of the Code Committee. One result of this cooperation is in the marking of tubular products. A section will be added to 24 of the Society's specifications for tubular products requiring a letter *X*, *Y*, or *Z* immediately following the specification number when it is stamped on the product to indicate that further processing is required by the purchaser in order that the material shall comply with the specification requirements. The purchaser must certify that all requirements of the specifications have been completed before removal of the letters *X*, *Y*, or *Z* from the specification number.

The guaranteed minimum yield point for structural steel was raised to 36,000 psi in the new revision of Specification A 36. While the price of the new steel is slightly higher than the former 33,000 psi yield point steel, this price increase is more than offset by the advantages of the higher guaranteed yield point for design purposes.

A significant first: New Specification A 441 is the first industry-wide specification for low-alloy structural steels containing manganese and vanadium. The material is intended primarily for welded bridges and buildings where savings in weight or added durability are important. Atmospheric corrosion resistance of the steel is significantly better than that of structural carbon steel. This, incidentally, is the first high-strength, low-alloy steel with specified chemical composition to be covered by an ASTM specification. Until now, such steels have been proprietary, with variable compositions and properties.

Two important specifications of nodular iron were developed during the year. A 439 covers austenitic iron, which is noted especially for its resistance to heat, corrosion, and wear. The graphite in this iron appears primarily as spheroids rather than flakes. Another new iron specification is A 445, covering nodular iron castings for valve bodies, fittings, flanges, and other parts intended for critical service and under pressure at elevated temperatures. Both these specifications will probably be adopted by the ASME Boiler and Pressure Vessel Committee.

Non-ferrous Metals

In non-ferrous metals, the trend is toward the development of specifications for specific types of products. Two examples are covered in Specifications B 359 and B 360, the former covering copper and copper-alloy condenser tubing, with integral fins, for use in surface condensers, evaporators, and heat exchangers.

Specification B 360 covers copper capillary tubing suitable for use in metering lines for liquids or gases where close control over the smoothness and dimensions of the bore is required to ensure uniform flow.

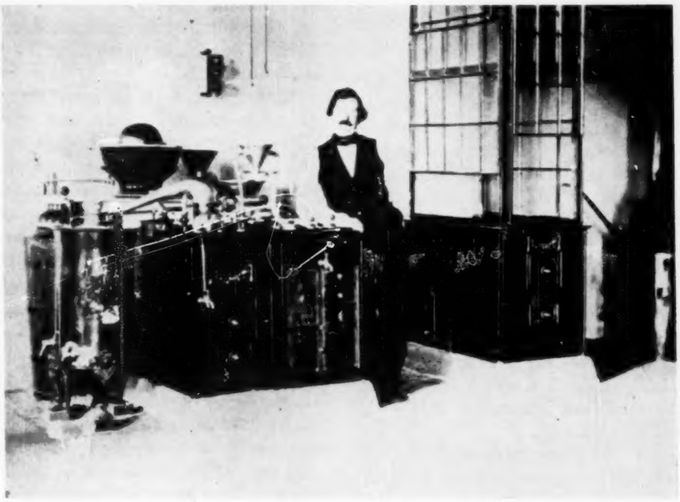
The Society continues to develop specifications for materials of construction for the chemical industry, often on specific request from such organizations as the Manufacturing Chemists Assn. and the Chemical Industry Advisory Board. An example is the new Specification B 361 covering aluminum and aluminum-alloy fittings. The specification covers butt-welding or socket-end parts, such as elbows, caps, tees, reducers, lap-joint stub-ends, and other types covered by American Standards B 16.9 and B 16.11 for steel welding and socket fittings. Similar specifications are being prepared for copper and copper-alloy and for nickel and nickel-alloy fittings.

For the fast-growing nuclear industry come a number of specifications for zirconium—for zirconium sponge (B 349); ingots (B 350); bars, rod, and wire (B 351); sheet, strip, and plate (B 352); and for seamless and welded tubes (B 353).

Metallography

There is now available an additional grain size chart designated Plate II of methods for estimating the average grain size of metals (E 112). This chart was developed after an extensive cooperative program in Committee E-4 on Metallography. It is hoped that the new grain size chart, with the revised methods E 112, will replace other methods presently used by industry under ASTM Designations E-19 (steels), E 79 (copper), E 89 (low-carbon steels),

An Early Chemistry Laboratory



University of Mississippi

BEFORE the educational expansion resulting from the Land Grant Act of 1862, there were few practical laboratories in American Colleges. Even for these few, early records are scarce and we know little about their appearance. Curiously enough, one of the earliest actual photographs of the interior of a laboratory (possibly it is the oldest such picture in existence) shows a chemist not otherwise recorded by history. This photograph, though unclear from the passage of time, shows the first chemical laboratory of the University of Mississippi, with its oven-like furnace and auxiliary equipment for hot filtration, etc. The gentleman is identified as Captain E. C. Boynton, a graduate of West Point, who acted as Professor of Chemistry at Mississippi, 1856–1861. Presumably the photograph must be dated also within this period.

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and E 91 (non-ferrous metals other than copper). Methods E 112 are general and cover all metals.

Metallic Coatings

An interlaboratory survey of microhardness testing as applied to electrodeposited metallic coatings was undertaken in 16 laboratories. Coatings of bright nickel, Watts-type nickel, and acid copper gave a good range of hardness values. Two thicknesses were selected. The closest check results were obtained by instruments using indent techniques. The variation of results in this survey, however, were quite large. Committee B-8 on Electrodeposited Metallic Coatings will review the results to determine how to pursue this to a successful conclusion.

Work is continuing on development of a solderability test method for tin and tin-alloy coatings following storage. Other methods being developed include adhesion tests and ductility tests for plated coatings and thickness tests for anodized aluminum coatings.

Research quantities of a new dye solution to determine the sealing of anodically coated aluminum (Method B 136) are being distributed to workers in this field to obtain data on the reproducibility of the dye test results.

Atmospheric Corrosion

The Advisory Committee on Corrosion has published a review of ASTM atmospheric corrosion studies of iron and steel undertaken since 1905. This committee continues to maintain 17 atmospheric exposure test sites throughout the country. Recently, the site near Tucson, Ariz., was discontinued.

Committee A-5 on Corrosion of Iron and Steel is preparing a series of 51 types of unfabricated and fabricated wire for a study of the atmospheric corrosion resistance of aluminum-coated steel wire. These wire and fencing specimens will be exposed at four coastal sites, one industrial site, and two rural sites.

Data from the 1936 exposure test of wire, farm field fencing, and other fabrications following 20 years' exposure at 11 test sites have been evaluated and will be published as the Twenty-Year Atmospheric Corrosion of Zinc-Coated Wire and Wire Products (*STP 290*).

Aluminum- and zinc-coated steel roofing sheets were exposed at five test sites in September. This test will evaluate the differences, if any, between single-dip and continuous-dip galvanized coatings as well as atmospheric corrosion resistance of hot-dipped aluminum coated steel sheet.

Committee A-7 on Malleable-Iron Castings developed its first year of data from exposures of malleable iron, pearlitic malleable iron, and nodular iron specimens at five test sites. Although preliminary data have been reviewed by the committee, publication may be held in abeyance until the three-year data are available.

Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys has collected test data showing changes in tensile strength and fatigue strength of 17 grades of commercial stainless steel exposed to the atmosphere at six locations. The results, although very interesting, will not be published until the three-year data are available, so that trends can be more definitely established.

Committee B-3 on Corrosion of Non-ferrous Metals and Alloys has begun the exposure of steel and zinc specimens at six test sites that also contain apparatus for determining time-of-wetness and sulfur dioxide content of the atmosphere. This work is being carried out jointly with the National Research Council of Canada.

A study has begun to determine the relative corrosivity of 41 exposure sites in Canada, the United States, England, the Canal Zone, and the Phillippines. Specimens will be exposed at one- and two-year periods to correlate the relative corrosivity of these test sites over a total three-year period.

Data from the first and second years of exposure of 74 specimens of non-ferrous metals and alloys are being compiled; this program began in 1958.

Committee B-4 on Metallic Materials for Thermostats and for Electrical Resistance, Heating, and Contacts has placed on exposure two enclosures at Newark, N. J., and Kure Beach, N. C., test sites to determine the effect of industrial and marine atmospheres on electrical contact metals. Each shelter contains 720 contact wires for making 360 static contacts; 100 metal foils are also included for film growth measurements, to be made in cooperation with Stanford Research Inst. These metals include gold, silver, nickel, tin, palladium, beryllium-copper, and other electroplated coatings, metal-dipped coatings, and surface treatments.

In 1953, Committee B-6 on Die-Cast Metals and Alloys prepared specimens of aluminum die-casting alloy SC84A with five zinc contents to determine the effects of zinc content on corrosion resistance. The six-year exposure data for these specimens, placed in a marine and an industrial atmosphere to determine change in tensile strength, per cent elongation, and yield strength, have been published in the 1960 report of this committee. The 20-year exposure data for four magnesium and three zinc alloys exposed at five outdoor sites and three storage locations have been obtained, and a final report of this test program is in preparation.

Committee B-7 on Light Metals and Alloys, Cast and Wrought has published the data from the five-year exposure of sand and permanent-mold castings, as well as wrought specimens of aluminum and magnesium alloys.

Committee B-8 on Electrodeposited Metallic Coatings is planning program No. 5 to compare the performance of commercial and heavier chromium-nickel coatings on steel. Several techniques including multiple nickel (duplex) plating will be included. Specimens are also being prepared for atmospheric exposure of decorative chromium-nickel coatings on aluminum alloys (program No. 6) and zinc die castings (program No. 7).

Some data have been obtained from one portion of the study on chromate-treated cadmium-plated steel specimens (program No. 102). Exposures for this study are continuing at Kure Beach, N. C. and Rock Island Arsenal, Ill.

Committee C-19 on Structural Sandwich Constructions is continuing to obtain data from the second and third exposure programs for sandwich panels exposed at State College, Pa., and Kure Beach, N. C. A fourth program is being assembled. Some of the data from the first program have been published (*STP 270*, page 9).

Effect of Temperature on the Properties of Metals

Following the successful conclusion in 1960 of its campaign to raise $150,000 to support its research, the joint ASTM-ASME committee initiated new programs and completed others.

Strength property data on ferrous metals and high-temperature alloys will be screened to establish whether they fall within limits of appropriate specifications. Data found suitable will be then presented, in a form for ready evaluation, to the Subgroup on Metals Engineering of the ASME Boiler and Pressure Vessel Committee's Subcommittee on Ferrous Materials.

A survey resulted in the publication of a 314-page report, *STP 291*, summarizing elevated-temperature properties of commercially established aluminum and magnesium alloys. The data are of the type used in determining allowable stresses for the Unfired Pressure Vessel Code of the ASME Boiler Code Committee, and cover those alloys used in the aircraft industry for elevated-temperature applications.

A survey on physical properties of metals from cryogenic to elevated temperatures is under contract to Battelle Memorial Inst. and will result in a special technical publication early in 1961.

The Gas Turbine Panel is looking into the problems of aircraft jet engine

operations, both military and commercial. The most important problem here appears to be creep damage—there is a need to know how much life is left in a turbine bucket after a period of service, and whether the parts can be rejuvenated by suitable heat treatment. A task group will appraise the present status of our knowledge, compile field histories, and recommend to the committee a course of action.

A report on the use of austenitic stainless steels in main steam line service issued in 1960 stated that no way has yet been found to prevent crack sensitivity in weld-affected areas, nor has a suitable test been developed that can identify this sensitivity early enough in the piping manufacturing process to prevent considerable loss by rejection. The project committee therefore issued a warning statement on the use of type 347 stainless steel in heavy sections for power piping service.

A report has been issued showing good progress in identifying the factors that affect the high-temperature strength of type 321-H stainless steel. One significant statement in the report: "The work of this project to date shows that tubing made to type 321-H grade in ASTM Specification A 213 appears to be suitable for high-temperature superheater service at present code-allowable stresses."

As a result of extensive surveys to determine the aircraft industry's problems, task groups have been appointed to develop recommended practices for: (1) determining compression properties of sheet materials at elevated temperatures and at conventional strain rates, (2) compression testing at elevated temperatures with high rates of heating and rapid strain rates, and (3) compression, bearing, and shear creep testing.

Chemical Products, Petroleum, Fuels

Paint

A new type of method for hiding power of nonchromatic paints now available (D 1738) is based on a statistical procedure employing Kubelka-Munk equations. The first test for the new-type latex paints, a test for efflorescence of interior paints, was completed. Other tests being completed for latex paints cover scrub resistance, freezing and thawing stability, resistance to biological spoilage in containers, and package stability. Other important new methods cover preparation of surfaces of aluminum alloys (D 1730), hot-dip aluminum (D 1731), and magnesium alloys for painting, and preparation of concrete and masonry panels for testing paint finishes (D 1734). Another milesone is the method for water-fog testing of organic coatings, which is useful for comparing paint systems on metal substrates for resistance to blistering and corrosion. Two important new methods dealing with appearance are the test for color change of white architectural enamels (D 1543) and for visual evaluation of color differences of opaque materials (D 1729).

Petroleum

At its October meeting in Washington, D. C., Committee D-2 on Petroleum Products and Lubricants sponsored a symposium on non-Newtonian viscometry, which presented information on the latest techniques in studying problems associated with the measurement of non-Newtonian flow of mineral oils and constituents. This symposium will be published as an STP.

Committee D-2 had the distinction of turning out the largest Annual Report—110 pages plus a series of eight appendices comprising 32 pages. This reflects the very high rate of activity in standards for petroleum products. The committee completed the first ASTM gas chromatography method for analysis of commercial butane-butene mixtures (D 1717). New ASTM tables for positive-displacement meter prover tanks (D 1750) were issued. An important test for jet fuels was the method for luminometer numbers (D 1740). In addition, Committee D-2 provided the new method for rust protection in the humidity cabinet (D 1748). A Karl Fischer method for determining water in liquid petroleum products was issued (D 1744). A new method for calculating absolute viscosity (D 1745) was a valuable addition to the existing viscosity procedures. Important changes were made in the kinematic viscosity methods (D 445). The test for water and sediment was divided into two methods, one for crude oils (D 96) and the other for lubricating oils (D 1796).

Coal and Coke

Two methods for physical testing of coal briquettes presented to Committee D-5 for consideration represent the first activity of a new subcommittee to cover briquettes.

Development of Method D 409 to include a wider and more complete range of grindability sizes stems from the desirability to specify narrow ranges of sizes for certain applications such as pipeline coal, fluid coke, and anthracite silt. Work also includes grindability studies on lignite at various moisture content. Sampling of pulverized coals is also being studied.

The long-range work to broaden the coverage of the analysis of coal and coke continues with methods for determining chlorine and forms of sulfur in coal.

Soaps and Other Detergents

Continued emphasis on analysis of synthetic detergents has resulted in new methods for the determination of ethylenediamine tetraacetate and sodium alkylbenzene sulfonate.

As a first step toward a tentative method for measuring redeposition of soil on cotton fabric, a proposed method for this test was published for information only. At best, such a test can furnish comparable results only for a given soil on comparable fabrics under controlled conditions, but standardized performance tests are felt to be needed and are receiving intensive study.

The Bibliographical Abstracts of Methods for Analysis of Synthetic Detergents has been brought up to date through 1959 by a new supplement issued this year. A supplement to the Metal Cleaning Bibliographical Abstracts, covering the literature for 1958–1960, will be available early in 1961.

Engine Antifreezes

Committee D-15 is continuing its long-term study to develop reproducible and significant methods for laboratory evaluation of the corrosive tendencies of engine antifreezes. Both the beaker test and the engine block method are under study.

Development of test methods for foaming tendency of engine antifreezes and the deleterious effects of antifreezes on automotive hose and automotive paints continues.

Industrial Aromatic Hydrocarbons

Committee D-16 work on styrene has resulted in the completion of four methods for aldehyde, inhibitor, and polymer content of styrene monomer, and solubility of styrene polymer. Methods for viscosity and color of styrene monomer are under development. Methods for purity of styrene by freezing point, and tests for peroxides, chlorine, and sulfur content are being considered.

Methods for phthalic anhydride covering solidification point, heat stability, and color of melt are being coöperatively tested.

Naphthalene standardization projects include color of the refined product, solidification point, and a comparison of three methods for sulfur.

A program to test the cloud point of phenol has begun, using phenols from the chlorobenzene, Raschig, sulfonation, and the cumene processes.

Refined methods for pyridine being developed cover water solubility, permanganate number, and oil content.

A new table to cover calculations of volume and weight of mixed xylene is being prepared for Tables D 1555.

Wax Polishes and Related Material

Cooperative testing continues in Committee D-21 to develop the James static coefficient of friction machine to determine the antislip properties of waxed floors. Various substrates including leather, Neolite, and glass are being tested, along with a variety of floor polishes.

Other methods being developed in the wax polish field include tests for resin content of carnauba wax, determination of silicones in wax polishes, removability, water spotting, discoloration, and powdering properties of water emulsion waxes. Tests for the water and abrasive contents of prewax automobile cleaners and polishes are also being developed.

Lime

Committee C-7 on Lime, recognizing the increasing need for standards for chemical lime, has established a new subcommittee on processing limestone for the chemical and process industries. Thus, Committee C-7, which has already developed a number of methods for chemical lime, serves both the construction industry and the chemical industry.

Chemical and Physical Analysis

It is becoming increasingly apparent, with the organization of more committees concerned with analysis, that each committee is interrelated with all the others. Often a substance cannot be adequately analyzed without resorting to the techniques covered by several of these E committees—E-2 on Emission Spectroscopy, E-3 on Chemical Analysis of Metals, E-13 on Absorption Spectroscopy, E-14 on Mass Spectrometry, E-15 on Analysis and Testing of Industrial Chemicals, E-16 on Analysis and Sampling of Ores, the new Committee E-19 now being organized to cover Gas Chromatography, and, finally, the Joint Committee on Chemical Analysis by Powder Diffraction Methods.

Nearly all of the ASTM technical committees are concerned with methods of analysis for the materials and products under their jurisdiction. For the most part, these committees are represented on appropriate E committees to help in standardizing techniques and analytical tools having general applicability.

Emission Spectroscopy

Committee E-2 has completed work on a new edition of the book of Methods for Emission Spectrochemical Analysis, which will be available early in 1961. New material in this 1960 edition will include tentative recommended practices for spectrochemical computations and for describing and specifying the excitation source in spectrochemical analysis; 32 new suggested methods and practices; and new tentative flame photometry methods for spectrochemical analysis for sodium and potassium in polyols (urethane foam raw materials) and for tetraethyllead in gasoline.

An extensively revised and enlarged edition of the Report on Standard Samples and Related Materials for Spectrochemical Analysis has been prepared and will be available early in 1961.

Two new symposium volumes are now available—the 1959 West Coast Symposium on Spectroscopy (*STP 269*) and the 1959 Annual Meeting Symposium on Spectroscopic Excitation (*STP 259*).

Chemical Analysis of Metals

The first ASTM methods for chemical analysis of molybdenum and of metal powders were issued in 1960. Thirty-three additional individual methods for chemical analysis of metals have been prepared for addition to existing tentatives and standards in preparation for the 1960 Book of ASTM Methods for Chemical Analysis of Metals. The recommended practices for apparatus and reagents and for photometric methods for chemical analysis of metals were revised, and new tentative recommended practices for conducting interlaboratory studies of methods have been issued.

Because of rapidly increasing activity in the analysis of the so-called refractory metals, such as titanium and zirconium, a new group on refractory metals is being organized.

Development has been started on the first ASTM methods for chemical analysis of alkali metals.

Absorption Spectroscopy

The recommended practices for general techniques of infrared and ultraviolet quantitative analysis were advanced to tentative status with the designations E 168 and E 169. The availability of these new tentatives should simplify the writing of specific methods for chemical analysis by absorption spectroscopy; certain descriptions of techniques can now be covered by reference to E 168 and E 169.

The Wyandotte-ASTM punched-card indexes to absorption spectra have been expanded to cover near-infrared, far-infrared, and visible-range spectra. Additional catalogs of spectra that are now indexed include those from the Anderson Laboratories, the Coblentz Society, and the Manufacturing Chemists Assn.

Mass Spectrometry

Symposia on photoionization, the precise measurement of uranium isotope abundance using uranium hexafluoride, solids analysis, and ion arrangement were included among the 85 papers on mass spectrometry presented at the Committee E-14 meetings held in conjunction with the 1960 Annual Meeting of the Society. All phases of mass spectrometry, including theory, instrumentation, and analytical techniques, were covered. A punched-card index to published mass spectra has been prepared by the committee, which will recommend that it be published in the same manner as the existing index to absorption spectra.

Industrial Chemicals

Industrial chemicals—those materials which are raw materials to some companies, finished products to others, and which range from sulfuric acid in tank-car quantities to kilogram lots of fine chemicals—are subjects for extensive efforts in standardization in Committee E-15 on Analysis and Testing of Industrial Chemicals, which now has been in existence a little less than two years. The present broad program of the committee covers not only general methods of analysis but also methods applicable to specific groups of chemicals such as mineral acids, alkalies, and alcohols. The committee also has active subgroups covering standards and reagents, sampling, and precision and accuracy of analytical methods. One of a number of active projects, in the Subcommittee on Physical Properties, is to develop and publish density-temperature tables for industrially pure liquid chemicals. These tables, similar to tables already available for petroleum products and for aromatics, will be useful as a standard basis for measurement acceptable both to buyers and sellers of chemicals.

Gas Chromatography

Based on recommendations of a conference held at the 1960 Annual Meeting the Society will organize early in 1961 a new committee, E-19 on Gas Chromatography, with the following recommended scope.

To promote the development and application of gas chromagraphy by:

(a) Coordinating scientific applications and methods of analysis based on gas chromatography in cooperation with other technical committees of the Society and other organizations.

(b) Cooperating with national and international bodies in standardizing presentation of data and nomenclature.

(*c*) Developing general methods and other appropriate standards.

(*d*) Providing a forum for exchange of information.

(*e*) Stimulating research in this field.

(*f*) Collecting and disseminating critical data.

The committee will also consider the establishment of subcommittees on nomenclature and definitions, programs and papers, research, standard data, and coordination and standardization of methods.

Electrical and Electronic Materials

Metals

The trend to higher temperatures in electronic circuits has prompted the development of a new specification for nickel-coated copper wire (B 355). The specification covers three classes of wire: nickel coating at least 4 per cent of the total weight of the coated wire; another class with at least 10 per cent nickel based on total weight, and a third class whose nickel coating is at least 27 per cent of the total weight of the coated wire. This specification supplements the specification for silver-coated copper wire (B 298), useful in electrical and electronic applications at lower temperatures.

Also in the field of electrical conductors are a group of definitions of terms (B 354). These definitions will help avoid confusion because of the expansion in recent years of the types of metallic conductors available and used by industry.

The magnetic properties of metals also received attention by the committee on that subject in bringing up to date, with extensive revisions, methods of test for magnetic properties of materials (A 343 and A 344), as well as an extensive revision of the methods for permeability of feebly magnetic materials (A 342). The committee on magnetic properties is developing a manual on magnetic testing and has current standardization projects on magnetic amplifier core materials, cut tape-wound cores, materials for magnetic shielding, d-c tests of high-coercive magnets, and high-frequency Epstein testing.

Committee A-6 has had discussions with Committee A-1 on Steel concerning the development of purchase specifications for magnetic materials. A new Subcommittee on Specifications is being activated in Committee A-6 on Magnetic Properties in cooperation with Committee A-1.

Wire for use in wire-wound resistors and similar applications was given attention in the extensive revision of the specifications for high-resistivity, low-temperature-coefficient wire (B 267). The revisions are extensive and the specification now serves as a convenient catalog of all the major types and grades of this kind of wire of commercial interest. Included in the specification is information on various insulating systems used with this type of wire, including wrapped textile coverings and enamels.

Perhaps the most stringent requirements for metals, both as to shape and composition, will be found in their application in various forms in electron tubes. The electron tubes committee, F-1, is revising specifications to include finer sizes of nickel and tungsten wires (F 290). The committee is also concerned with methods for measuring straightness of these fine wires, as well as diameter.

Electron-tube cathodes are in a special position in the metals field, since they involve application of coatings which actually are semiconductors. The committee has completed the development of a number of reference electron-tube testing devices, the most recent of which are a recommended practice for testing tube parts using a reference planar diode (F 11). This will supplement other recommended practices involving a reference cylindrical diode and a reference triode.

Semiconductors

The problems of developing standard methods for resistivity and lifetime of charge carriers in semiconductors have occupied the major attention of the subcommittee on this subject in Committee F-1 on Materials for Electron Tubes and Semiconductor Devices. Both these properties are important measures of the quality of semiconductor materials. The committee has not been able to establish standard tests for these properties as yet because of the difficulty of reproducing results in different laboratories. The assistance of the National Bureau of Standards has been requested to establish reference standards and, in general, to assist the industry in this standardization work.

The committee is currently evaluating resistivity methods involving capacitive contact to the specimen. Round-robin tests were conducted in four laboratories to make measurements on five samples of resistivities, 11, 150, 370, 380, and 1600 ohm-cm, using both fixed and movable plates. There was close agreement between two of the laboratories, the other two being erratic. Enough was learned about the procedure so that the method can now be drafted for broader consideration. Other projects in semiconductors include measures of oxygen in silicon, methods for determining orientation of the axes of single

Joseph Louis Lagrange
(1736—1813)

A TIMID, SENSITIVE MAN, Lagrange displayed no interest in mathematics until he reached the age of 17. He went on to become the greatest mathematician of the 18th century. His Mechanique Analytique, 1788, which was based on the idea of virtual work, is one of the most fundamental books on mechanics ever written. Lagrange was proud of the fact that the book contained no diagrams.

This is one of a series of photographs from a collection compiled by Prof. Jasper O. Draffin and displayed in the Arthur N. Talbot Laboratory, University of Illinois.

crystals, methods for determining lifetime of semiconductors, studies of silicon crystal growth, dislocations in crystals, mobility, and epitaxial vapor deposits.

Ceramics

Work on ceramics is going on in several fronts—in the new Committee C-25 on Ceramics for Electronics and in the Insulator Subcommittees of both Committee F-1 on Materials for Electron Tubes and Semiconductor Devices and Committee D-9 on Electrical Insulating Materials. Committee C-25 is assembling industrial methods used to test ferroelectrics at microwave frequencies, process control tests for ferroelectrics, and chemical tests for raw materials. Methods for compressive strength of electrical insulation at microwave frequencies and high-temperature properties of high-alumina ceramics are also being investigated. Four methods for determining various characteristics of nonmetallic magnetic materials have been reviewed by research workers in this field and by the National Bureau of Standards.

In the electron tube committee, attention is being given to the properties of ceramics parts used in electron tubes for which test methods may be needed. In particular, ceramics used in conjunction with sealing to metals are being studied particularly with regard to evaluating the properties of the seal itself. The Task Group on Leak Testing of Metallic-Nonmetallic Seals is developing methods for measuring this property.

Ceramics are also used for power insulators and for line insulators in communication as well as for electronics. Many of these latter uses are covered by the Subcommittee on Ceramic Insulation of Committee D-9. This group has recently completed revisions on the methods of testing ceramic materials (D 116) and is developing tests for insulation resistance at elevated temperatures and methods for measuring dielectric constant and loss factor of ceramics at microwave frequencies.

Electrical Insulation

Trends in the electrical insulation field are toward application at higher temperatures and with lower power losses at higher frequencies. Not only do these trends put pressure on the materials developers to provide materials serviceable under these conditions, but they also point up the need for extending present tests or developing new tests to evaluate materials under these conditions. In addition, the need for serviceable insulating materials under difficult environmental conditions of contamination and moisture have made it necessary to develop tests for measuring the quality of insulation used under these difficult conditions. All these factors have influenced the program during the past year of Committee D-9, which is developing test methods for dust and fog tracking resistance, for thermal stability and capability of insulation at elevated temperatures, for corona resistance of materials, and for measuring the properties of materials at high temperatures.

In the field of liquid and gaseous insulation, the new Committee D-27 has completed work on several new standards: several test methods for quality of chlorinated hydrocarbon liquids (askarels), a recommended practice for estimating temperature limits of liquids (D 1805), and a more sensitive method for measuring dielectric strength of liquids, using modified VDE electrodes (D 1816). The committee has also completed development of continuity specifications for liquids for low- and high-pressure cables (D 1818, D 1819).

While to date no standards have been developed relating to insulating gases, the committee has a number of projects under way, and perhaps the first standard to be developed will be one for nitrogen gas for insulating purposes. Projects are going forward to develop standards relating also to various halogenated gases, some of which may be considered as volatile liquids under normal conditions.

General Testing

Methods of Testing

Committee E-1 began work on thermal conductivity testing of metals and on linear expansion tests by organizing two new task groups.

Eleven papers from the Symposium on Shear and Torsion Testing, sponsored by Committee E-1 at the Annual Meeting, are now being prepared for publication as an STP.

Specifications for precision micromesh sieves (E 161) cover recently developed square-hole electroformed sieves, which are intended to serve mainly as a primary reference standard in place of the more sturdy woven-wire sieves. Significant changes were made in the specifications for sieves for testing purposes (E 11) as a result of certain proposals considered at the international meeting of ISO/TC 24 on Sieves.

An important addition to the specifications for ASTM thermometers (E 1) was a series of detailed requirements for six solvents-distillation thermometers requested by the paint committee, D-1. The specifications for apparatus for determination of water by distillation (E 123) were enlarged to include glass apparatus for testing soaps, naval stores, and similar materials.

Nondestructive Testing

A new method for liquid penetrant inspection (E 165) is of special interest in the testing of reactors and pressure vessels to show such surface defects as cracks, seams, laps, laminations, or lack of bond in metals and other nonporous materials such as ceramics, plastics, and glass. Another new and useful method, also under jurisdiction of Committee E-7 on Nondestructive Testing, is one for ultrasonic contact inspection of weldments. This latter method is an extension of Methods E 114, recommended practice for ultrasonic testing. The committee has also extended the reference radiographs to cover inspection of aluminum and magnesium castings (E 155). This valuable inspection tool was developed in cooperation with the Aerospace Industries Assn.

Radioisotopes and Radiation Effects

One of the major accomplishments of Committee E-10 on Radioisotopes and Radiation Effects during the past year was the establishment of tentative definition of terms relating to dosimetry (E 170). This is part of the committee's contribution toward establishing dosimetry standards useful in nearly all radiation work involving measurement of radiation effects on materials. The committee is endeavoring to establish some analytical procedures for materials based on the use of radioisotopes, in cooperation with several of the technical committees.

Fatigue

Committee E-9 expanded its sphere of activity by forming a new Subcommittee on the Statistical Aspects of Fatigue under the chairmanship of George R. Gohn of Bell Telephone Laboratories, Inc. Also under development is a new Task Group on Specimen Preparation. The results of this work will ultimately replace the present Section IV—Specimens and Preparation of the ASTM "Manual on Fatigue Testing," *STP 91*.

During the year the committee sponsored a Symposium on Acoustical Fatigue and two general sessions on fatigue; developed plans for the publication of a 10-year Bibliography on Fatigue; and compiled the annual "References on Fatigue," *STP 9-K*.

Through the years this committee has kept abreast of fatigue research in other countries through corresponding members. These correspondents from France, Australia, England, Sweden, Japan, and Germany report periodically to the committee the significant developments in their respective areas.

Appearance

Two recommended practices for goniophotometry, one applying to light-transmitting objects and the other to

reflecting objects were issued. Goniophotometry is a general procedure for evaluating the manner in which materials geometrically redistribute light.

Committee E-12 has undertaken a program to establish standards for carbon paper and typewriter ribbons. The aims of this activity are: (1) to compare methods now being used to evaluate the appearance qualities of the printed copy made by these products, (2) to determine whether improvements and new features are required, and (3) to prepare standard test methods for evaluating the color, density, sharpness, and other properties affecting the appearance of the printed copy.

A panel discussion on measurement of color and gloss of anodized high silicon aluminum alloys was sponsored by Committee E-12 during Committee Week in Chicago. The large attendance and discussion at the meeting reflected the growing awareness of the importance of this problem.

Quality Control

During the year, Committee E-11 on Quality Control of Materials has completed some minor revisions in the Manual on Quality Control of Materials, *STP 15C*, which has recently been issued in the seventh printing. This manual has long served as a standard reference in many laboratories and production plants.

The committee, aware of its broad responsibility to advise technical committees of the Society on statistical matters, expects to have available soon for reference purposes a number of manuals or recommended practices covering such subjects as treatment of outlying observations, interlaboratory test methods, precision and accuracy of test methods, fitting straight lines, and sampling of bulk materials.

Skid Resistance

The new Committee E-17 on Skid Resistance, organized at the 1960 Annual Meeting, will develop standard tests for determining traffic-surface slipperiness. While the committee's major efforts will be related to the problems of skidding of highway traffic, the work will not be limited to that but will cover all types of traffic surfaces.

Sensory Evaluation

Committee E-18 on Sensory Evaluation of Materials and Products, organized in October, will cooperate with other committees of the Society and with other organizations in developing principles and recommended practices for sensory evaluation. The committee will be concerned with such subjects as measuring the odor of various products, including paints, plastics, industrial water, etc.; evaluating comfort of textiles and leather; and developing methods suitable for determining off-taste which may be imparted to foods by packaging materials. The major effort will be in the broad area of principles rather than in the specific area of particular test methods. The test methods will be left to the technical committees covering the particular products.

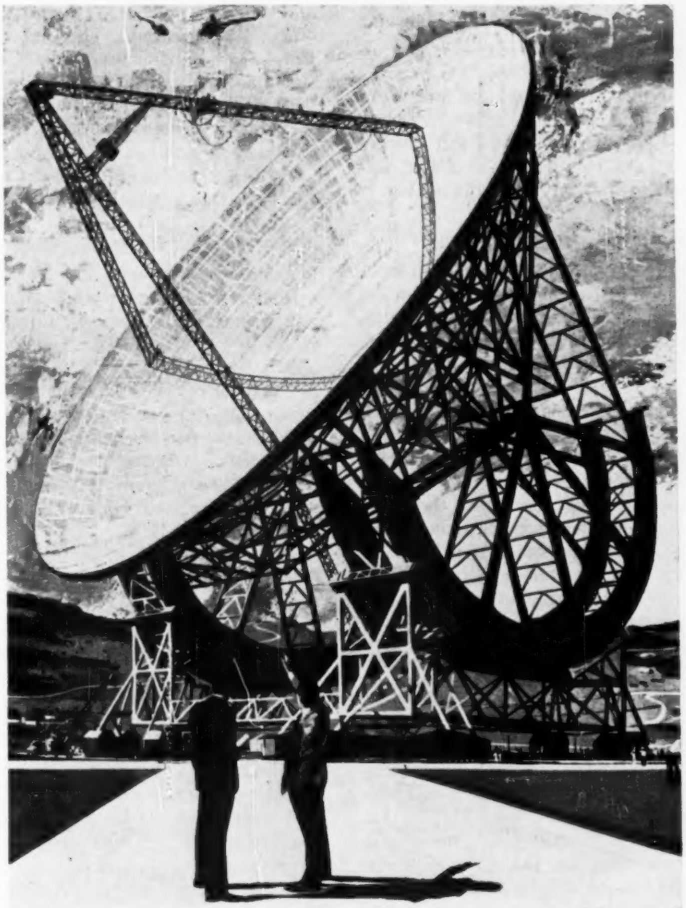
Industrial Water

Committee D-19 has entered the field of performance tests of materials for water treatment with the publication of the method of test for operating performance of cation-exchange materials—sodium cycle (D 1782).

The increased need for methods for radiochemical analysis of industrial water has resulted in the formation of a new D-19 subcommittee to cover this area. Related activities under way in other D-19 subcommittees including sampling radioactive water, a bibliog-

ASTM STANDARDS AT WORK

Uncle Sam's Seven-Acre Ear



Courtesy Reynolds Metals Co.

ARTIST's concept of world's largest radio-telescope being built for the U. S. Navy at Sugar Grove, W. Va. Higher than a 60-story building, the telescope has an aluminum reflector dish covering seven acres—enough room to house Yankee Stadium.

ASTM standards used to specify the more than two million pounds of aluminum:

B 209 (plate)
B 221 (extruded shapes)
B 235 (extruded tube).

Prime contractor is North American Aviation, Inc. Aluminum is being supplied by Reynolds Metals Co.

raphy on radioactivity in industrial water, and specifications for "heavy water."

A committee-sponsored research project for vaporous carryover in boilers has recently been completed and results are being evaluated. It is expected that a full report on this project will be presented at a symposium on steam impurities at the 1961 Annual Meeting.

Atmospheric Sampling and Analysis

In the measurement of dust fall from various industrial processes, one of the problems is how to avoid interference from such debris as matter from trees, insects, and bird droppings. This problem is considered in the new method for collection and analysis of dust fall (D 1739) approved last year on recommendation of Committee D-22 on Methods of Atmospheric Sampling and Analysis. During the year, the committee's representatives participated in discussions with the American Public Health Assn. concerning a proposal to develop a comprehensive manual for examination of the atmosphere.

Construction Materials

Cement

The use of processing additives in the manufacture of portland cement received considerable attention in Committee C-1 during 1960. Up to this time, the committee had recognized materials used for this purpose by a study of tests of each individual material to determine its effect when added in the amounts specified. A new specification was developed and has now been accepted embodying the significant requirements of this type of additive.

Chemical-Resistant Mortars

Committee C-3 has approved an expansion of its scope, in response to a real need for standards for materials other than mortars. In addition to chemical-resistant mortars the committee now proposes to develop standards covering chemical-resistant hot-melt compounds, adhesives, putties, and monolithic surfacing compounds.

Concrete and Concrete Aggregates

Admixtures for concrete have been given extensive study and research in Committee C-9, following the symposium on this subject presented at the Third Pacific Area National Meeting in San Francisco in 1959. Three areas have been studied by task groups covering chemical admixtures, pozzolans, and air-entraining agents. Proposed specifications were drafted covering the retarder and accelerator types of admixtures. The latest form of proposed specifications will feature a table grouping all requirements.

At the Annual Meeting, the Cement and Concrete Reference Laboratory was officially organized. This laboratory will be an expansion of the Cement Reference Laboratory under the jurisdiction of Committee C-1 on Cement. A joint subcommittee composed of equal representation from Committees C-1 and C-9 will administer the operations of the laboratory.

Mortars for Unit Masonry

A proposed specification for mortar and grout for reinforced masonry received the attention of Committee C-12 during 1960. This specification covers two types: type PM, consisting of equal parts of portland and masonry cement with aggregates; and type PL, consisting of portland cement, hydrated lime, and aggregates. A cooperative mortar test program was completed, with data submitted by five cooperating laboratories.

Concrete Pipe

Reinforced concrete manholes will be covered by a specification developed by Committee C-13. This specification covers precast reinforced concrete manhole risers and tops up to 72 in. in diameter for use in the construction of manholes for storm and sanitary sewers.

Specifications for cast-in-place nonreinforced-concrete closed irrigation conduit were approved for letter ballot of the committee. These specifications recognize a new type of pipe construction for conduit suitable for use in rural areas for the conveyance and distribution of irrigation water and agricultural drainage under low hydrostatic pressures.

Thermal Insulating Materials

A classification system was proposed in Committee C-16 as part of a special study given to the philosophy of specifications. By this system the consumer is aided in selecting the ASTM specification which suits his application. A new type of insulating material known as "rigid reflective sheathing board" was recognized, with the responsibility for the development of a specification being assigned to the Subcommittee on Reflective Insulation.

Natural Building Stones

The five common types of building stone—slate, granite, marble, limestone, and sandstone will ultimately be covered by ASTM specifications as part of the program of Committee C-18. By year's end specifications had been accepted and published for roofing slate (C 406) and for structural granite (C 422). Also published was a proposed specification for structural marble.

Acoustical Materials

The correlation of test methods for sound absorption with the large-scale reverberation room method (C 423) was studied by Committee C-20 during 1960. Associated with this was a round-robin test program involving the study of the box method. Another method, known as the "horn-coupler" method, was drafted based on test data from three installations.

Ceramic Whitewares and Related Products

An interlaboratory study to determine the specular geometry best suited to determine degrees of matness of ceramic wall tile resulted in the choice of the 60-deg angle of reflection which gave the widest spread of values for a variety of mat glazed tile. The committee is studying two procedures for craze resistance—one for whitewares involving cold water shock after dry heat soaking at 300 F, the other for ceramic tile with moisture expansion in the autoclave at 375 psi and subsequent cooling to room temperature.

Porcelain Enamel

Committee C-22 has completed development of a procedure to determine the resistance to spalling of porcelain enamel on aluminum by immersion in an ammonium chloride test solution. There has been no authenticated case where properly tested specimens passed the spall test and subsequently spalled in service.

Joint Sealants

Three subcommittees were active in 1960 in the new Committee C-24. Definitions of needed terms were considered, including a review of all existing ASTM definitions. Test procedures are being prepared as a basis for a specification for bulk compounds. A proposed general specification covering six types of elastomeric compounds was agreed upon as a guide in developing test procedures. Round-robin test programs were initiated to supply the necessary technical data on which to base specification requirements.

Wood

The principal accomplishments in 1960 of Committee D-7 consisted of the development and acceptance of methods for evaluating the resistance of wood and wood-base materials, such as plywood and modified wood, to direct withdrawal of screws (D 1761); conducting shear-block tests for quality control of glue bonds on scarf joints (D 1759); evaluating wood preservatives by field tests with stakes (D 1758) and the

chemical analysis of wood charcoal (D 1762).

Bituminous Materials for Roofing, Waterproofing, and Related Building or Industrial Uses

Specifications for bituminized fiber pipe were completed and submitted to letter ballot of Committee D-8. A specification for glass fabric saturated with bituminous materials, representing one of the newer materials used in built-up roofs, was completed by the responsible subcommittee. A new Subcommittee on Industrial Pitches was formed during the year, representing an expansion of the area of interest of the committee to cover a material differing in properties and characteristics from those of bituminous roofing and waterproofing.

Fire Tests of Materials and Construction

Two so-called "small-scale" types of fire tests were recognized by Committee E-5. The radiant panel method for measuring the surface flammability of materials (E 162) was accepted by the Society. A second test method for measuring surface flammability using an 8-foot tunnel furnace was approved by the committee for publication as information only. Methods of fire tests applicable to window assemblies, including glass block and other light-transmitting assemblies (E 163), were promulgated and accepted by the Society. The Method of Test for Surface Burning Characteristics of Building Materials (E 84) was revised to conform with the latest changes in the apparatus and procedure and in accordance with the method used by the Underwriters Laboratories.

MATERIALS SCIENCES

Bridgman on Density and Strength

Critique of Critical Tables, an article by P. W. Bridgman, professor of physics, Harvard Univ., which appeared in the *Proceedings* of the National Academy of Sciences, Vol. 46, 1960, provides some food for thought on two very important properties of materials and their relation to structure. The International Critical Tables published in this country in the late 1920's by McGraw-Hill included, in one of the several volumes, properties of engineering materials. Following are Prof. Bridgman's comments on two of these properties and on the problems of tabulation of critical values because of the variables that affect them.

Density

Mention of van der Waals' equation of state brings up another sort of consideration fundamental to the construction of critical tables. A complete reproduction of the density (or volume) of any substance demands that it be given as a function of all the variables which are known to affect it. In general, these variables include such things as electric or magnetic fields, but for most purposes we may consider only the most important variables, which may be taken to be simply pressure and temperature. Even with this reduction, the complete tabulation of density as a function of pressure and temperature, would usually demand a prohibitive amount of space. In many cases the experimental material can be reproduced by one or the other of the many equations of state that have been proposed, and the purpose of the tables is fulfilled if the constants of the equations for such substances are tabulated instead of the full range of experimental material. But these equations of state are usually erected on some sort of theoretical foundation, and acceptance of a specific equation involves some sort of commitment with regard to what is to be expected when the experimental range is extended beyond that now attainable. In such cases, some discussion of the theoretical background of the equation is necessarily involved in any critical presentation of the material. It may be that our theoretical understanding is not sufficient to justify any *deduction* of an equation of state, but that nevertheless empirical equations can be found which reproduce the experimental results within experimental error. In some other cases, it may be that our theoretical understanding, although incomplete, may be good enough to suggest that a particular type of equation is better adapted than some other. In such cases, discussion of the reasons for preferring this or that type of equation should be included with the numerical material.

Strength

There is another sort of physical parameter which in practice is subject to much greater fluctuation than density, namely, breaking strength. Under the conditions of daily life, fracture is one of the most unmistakable things that can happen to one. Fracture is always catastrophic, irreversible, and there is no question when it has occurred. Nevertheless, in spite of the definiteness of the phenomenon, the parameters which characterize it are among the most indefinite of the parameters which it is the task of a critical table to tabulate. The breaking strength of different specimens of ostensibly the same material may vary in a way frustratingly discouraging when it comes to practical applications. Differences of constitution which for other phenomena may be unimportant may be decisive with regard to strength, such as slight differences of chemical composition, or of surface condition, or of past history. We are gradually acquiring a better understanding of the way in which some of these obscure factors work, and also the ability to make specimens more reproducible with regard to fracture phenomena, but still our control is much less adequate than with respect to nearly all other physical parameters. Added to the practical difficulties there is a conceptual difficulty, for the concept of breaking strength becomes continuously less applicable when conditions are suitably varied, and eventually fails altogether. In particular, by raising the hydrostatic pressure to which a material is subjected the reduction of area before fracture may be increased indefinitely, so that eventually the material becomes incapable of tensile fracture and exhibits perfect plasticity. A further difficulty now appears, because in the plastic range the behavior of the material is by no means uniquely defined, but there are different kinds of plasticity, one or the other of which may be called "perfect" from one or another point of view. Furthermore, in the plastic range a formidable difficulty of principle appears, because no reversible displacements whatever are possible. This means that it is impossible, at least for the present, to even define an entropy for the material. On the other hand, it has to be assumed that the material has an entropy whenever it is characterized in thermodynamic terms, as it is for purposes of a table. In spite of all this, it is essential for practical purposes to attempt to give in a critical table some characterization of the behavior to be expected of ordinary materials in the range of fracture and plastic flow. It does not as yet appear even what are the best sorts of parameters in terms of which to attempt the characterization. We are here dependent to an unusual degree on the expert in charge of this part of the table.

This discussion has been concerned almost exclusively with parameters which may be characterized as "mechanical," namely, density and strength. But I think it is evident that somewhat similar considerations could have been advanced with regard to the other parameters which are the proper subject matter of critical tables, such as the electrical or optical parameters. Always, I think, the same sort of situation will be encountered, namely, that as the accuracy of measurement is increased and as we become acquainted with a wider range of new phenomena, it will become increasingly difficult to exhaustively define the conditions that are necessary to obtain reproducible results. Never will it be possible to deal with a world like this in a completely formal manner, nor will it ever be possible to reduce the construction of a set of critical tables to a rigid set of rules. Always will inspired common sense remain the most important requirement of those who are to produce the tables.

Society Affairs

Texas Student Receives ASTM Grant

WILLIAM MARSH RICE University, one of five universities to receive an ASTM grant-in-aid in 1960, has awarded its grant to Sidney P. Victory, Jr., a graduate assistant and fellow in civil engineering. Mr. Victory is working toward a Master of Science degree, and this year is engaged in full-time research related to the failure of a nonisotropic material subjected to triaxial stress.

SIDNEY P. VICTORY, JR.

This research is being performed in order to investigate the behavior of mortar and neat cement under three-dimensional stresses. The effect of lateral stresses on the longitudinal strength of ½-in. diameter by 1-in. long cylinders with both empty and saturated voids is being studied. The lateral and pore pressures will vary from 0 to 20,000 psi, and the scope of the work will include both tensile and compressive longitudinal stresses. The results of these tests will help in formulating the mode of the actual breakdown and failure of this material under these conditions. Earlier work along some of these lines was performed at Rice by Mr. Erkin Erkmen under the supervision of Professors James R. Sims and Nat W. Krahl. Mr. Victory's research is an extension of Mr. Erkmen's work and is also being done under the supervision of Professors Sims and Krahl.

Mr. Victory, a native of Houston, Tex., received his B.S. in civil engineering from the University of Houston in 1959. While an undergraduate there, he received an ASTM Student Membership Award for his work in materials testing. He is an associate member of the American Society of Civil Engineers, and a member of the Texas Society of Professional Engineers.

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NEW ASTM PUBLICATIONS

Supplements to Book of Standards: 7 of 10 Parts Now Available

THE 1960 SUPPLEMENTS to the 1958 Book of Standards are being published in ten parts in heavy paper covers. They include new and revised standards and tentatives adopted or accepted at the 63rd Annual Meeting or by the Administrative Committee on Standards. Parts 2, 3, 4, 5, 6, 7, and 8 are available now; the remaining parts will be available shortly. In the following list, the parts now available are shown in boldface type.

Part 1—Ferrous Metals (Specifications)
Part 2—Non-ferrous Metals (Specifications), Electronic Materials
Part 3—Methods of Testing Metals (Except Chemical Analysis)
Part 4—Cement, Concrete, Mortars, Road Materials, Waterproofing, Soils
Part 5—Masonry Products, Ceramics, Thermal Insulation, Acoustical Materials, Sandwich and Building Constructions, Fire Tests
Part 6—Wood, Paper, Adhesives, Shipping Containers, Cellulose, Leather
Part 7—Petroleum Products, Lubricants, Tank Measurements, Engine Tests
Part 8—Paint, Naval Stores, Aromatic Hydrocarbons, Coal and Coke, Gaseous Fuels, Engine Antifreezes
Part 9—Plastics, Electrical Insulation, Rubber, Carbon Black
Part 10—Textiles, Soap, Water, Atmospheric Analysis, Wax Polishes

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Gypsum Products and Plaster Aggregates, With Related Standards

Compilation of Standards, C-11

THE 1960 EDITION OF the compilation of ASTM Standards on Gypsum Products and Plaster Aggregates, With Related Standards, will contain the current 16 specifications, 11 methods of test, and 4 sets of definitions relating to gypsum products and plaster aggregates.

Specifications for gypsum backing board and the method of test for surface burning characteristics of building materials have been added since the previous edition. Revisions have been made in 5 specifications, 7 methods, and 1 set of definitions retained from the previous edition.

ASTM Standards on Gypsum Products and Plaster Aggregates, With Related Standards, 148 pages, hard cover, price $2.75, to members $2.20.

Building Construction Materials

LAMINATED WOOD beams have found a very useful place in structures, not only by providing a structural element able to bridge long spans, but also by permitting the use of more common pieces of timber not otherwise long enough for this purpose. An all-important factor in the performance of these beams is the joint between pieces. A paper in this volume reviews a series of strength studies of scarf joints in laminated wood beams. Another paper stresses the need for quality control and inspection of glued-laminated timber.

Two papers in this volume discuss the testing of diaphragms, a type of structural framing that has come into considerable use in areas subject to earthquake shock and strong wind forces. Other interesting subjects covered are a timely review of wood-pole-type buildings, the use of which has increased considerably in recent years; the strength and related properties of wood poles, as reflected by a very comprehensive research program conducted by Committee D-7 on Wood; the screw-holding ability of Western woods; deflection limitations as a factor in structural timber design; and methods for determining the useful strength of yard lumber of common grades.

Quite a far cry from the design and testing of building structures is the problem of termite control. One paper reviews the methods of approach used in California, where perhaps the greatest infestation occurs.

Finally, one paper has been included on light-gage steel building construction. The contents are:

Introduction—L. C. Gilbert
Quality Control and Inspection—Frank J. Hanrahan
Deflection Limitations as a Factor in Structural Timber Design—R. E. Eby
The Testing of Diaphragms to Determine Adequacy in Resisting Horizontal Forces—S. B. Barnes
Testing of Large Diaphragms—R. D. Cousineau
Strength Studies of Scarf Joints in Laminated Wood Beams—Jack Longworth and Christian K. A. Stieda
Screw-Holding Ability of Western Woods: Effects of Test Variables—J. W. Johnson
Wood Pole-Type Buildings—W. D. Keeney
Strength and Related Properties of Wood Poles—E. C. O. Erickson and L. W. Wood
Determining the Useful Strength of Yard Lumber of Common Grades—T. K. May
Termite Control in California Residential Construction—Walter Ebeling
Lateral Shear Tests of a Light Gage Steel Building—John J. Holstein

STP 282, 116 pages, price $3.50, to members $2.80.

Technical Developments in the Handling and Utilization of Water and Industrial Waste Water

THE DUAL problem of supplying enough suitable water for our expanding industry while at the same time increasing the supply of unpolluted water for our growing population is covered in this symposium volume. The general areas covered are: radioactive waste water, water for reactor cooling, pollution problems, irrigation, and increase in the supply of fresh water.

Since greater quantities of radioactive wastes have been generated and disposed of or stored in interim containers at Hanford than at any other atomic installation, the control measures developed there and described in one paper are of particular interest. Another paper covers methods developed by the U. S. Geological Survey for determination of radioactive materials in water.

Development of systems other than the once-through circulating systems can lead to the use of cooling towers in conservation and pollution control. The conditioning of filter systems with high-molecular-weight polymers improves the quality of water for once-through reactor cooling, with substantial increases in water plant capacity and savings in cost. These subjects are covered in two papers.

Two papers on the general subject of pollution cover (1) methods developed by the California Department of Water Resources for disposal of oil-field brines to injection wells and other areas not affecting usable water supplies, and (2) the effects of industrial wastes on irrigation water, with a discussion of pollutants, their mode of action, and suggested control measures including plant tolerance studies.

The electric-membrane or electrodialysis process for removing excess dissolved salts and minerals from water has been used at Coalinga, Calif., using both the batch-type and the continuous electric-membrane demineralizers, with reported satisfactory results, thus showing one way of increasing the fresh water supply. Another, solar distillation of saline water, is described in another paper. Designs and materials for stills are discussed and comparisons given of

glass and plastic installations. Advantages, fabrication and sealing techniques, and maintenance costs of plastic installations are emphasized.

The contents include:

Introduction—William L. Lamar

Disposal of Industrial Radioactive Waste Waters at Hanford—L. C. Schwendiman, R. E. Brown, J. F. Honstead, C. E. Linderoth, and D. W. Pearce

Determination of Radioactive Materials in Water—Franklin B. Barker

Utilization of Cooling Towers in Conservation and Pollution Control—Joseph J. Finnerty

Improvements in Water Treatment for Once-Through Reactor Cooling—R. B. Richman

Disposal of Oil-Field Brines in the Central Valley of California—James M. Morris, Jr.

Effect of Industrial Wastes on Water for Irrigation Use—L. V. Wilcox

Operation of Batch-Type and Continuous Electric Membrane Demineralizers—William E. Katz

Solar Distillation of Saline Water with Particular Regard to Materials Problems—R. P. Lappala, L. L. Yaeger, and J. A. Bjorksten

STP 273, 98 pages, hard cover, price \$3.00, to members \$2.40.

Cement

Compilation of Standards, C-1

THE 1960 EDITION OF the compilation of ASTM Standards on Cement will contain the current 8 specifications, 26 methods of test, and definitions relating to portland cement and other hydraulic cements. Two specifications for essential laboratory apparatus also are included.

Methods added to this compilation since the previous edition cover false set of portland cement (paste method), fineness of hydraulic cement by the No. 325 sieve, and potential sulfate resistance of portland cement. Revisions have been made in 4 specifications and 8 methods retained from the previous edition, and also in the definitions. Changes and additions have been made in the appended Manual of Cement Testing and Selected References on Portland Cement.

ASTM Standards on Cement, 296 pages, hard cover, price \$4.00 to members \$3.20.

Whither Gasoline Specifications?

CURRENT RESEARCH on motor gasoline may ultimately result in more significant methods of test for gasoline quality and in revisions to the ASTM Specifications for Gasoline, D 439.

To keep informed of developments, Technical Committee A on Gasoline, of ASTM Committee D-2, is sponsoring a Symposium on Current Research on Motor Gasoline that May Affect Future Specifications. The Symposium will be held on February 7, 1961, at the Benjamin Franklin Hotel, Philadelphia, Pa.

Prepared discussions by qualified petroleum technologists will follow each of the following papers:

The Role of Motor Gasoline Additives—J. M. Dempster, The Standard Oil Co. (Ohio).

Gasoline Stability—R. O. Bender, E. I. du Pont de Nemours & Co., Inc.

Composition, as It May Affect Specifications—W. J. Faust, Universal Oil Products Co.

Motor Fuel Volatility Characteristics and Specifications—T. W. Legatski and O. C. Bridgeman, Phillips Petroleum Co.

Present and Future Requirements of Motor Gasoline to Meet Needs for Satisfactory Engine Performance—T. H. Risk and A. E. Cleveland, Ford Motor Co.

Relation Between Laboratory Knock Ratings and Customer Satisfaction on the Road—J. E. Getz and T. O. Wagner, American Oil Co.

Other Abnormal Combustion Phenomena—Are Gasoline Specifications Necessary?—D. L. Pastell and K. Hyatt, E. I. du Pont de Nemours & Co., Inc.

Summary of CRC Work on Antiknock—H. J. Gibson, Ethyl Corp.

Present Status and Objectives of Research Division I (ASTM Committee D-2) Work on Laboratory Antiknock Determination—F. C. Burk, The Atlantic Refining Co.

Summary—D. P. Barnard.

COMING MR&S PAPERS

Intercrystalline Cracking and Creep Rupture Life—H. H. Bleakney, Department of Mines and Technical Surveys, Canada.

Apparatus for Hardness Testing at Sub-Atmospheric Temperature—L. L. France, Universal Cyclops Steel Corp., R. T. Begley and H. Kohute, Westinghouse Electric Corp.

Good and Bad Effects of Nuclear Radiation on Rubber—J. W. Born, The B. F. Goodrich Co.

Subsize Charpy Correlation with Standard Charpy—C. H. Curll, Watertown Arsenal Laboratories.

A New Method for the Determination of Undissolved Water in Fuels—L. Gardner, National Research Council of Canada.

The Determination of Nickel Thickness by the Electromagnetic Test Method in Heat-Sink Development—C. H. Hastings and S. A. Lopilato, AVCO Research and Advanced Development.

Stress-Rupture Tests at 1350 F on Type 304 Stainless Steel—W. D. Jenkins, W. A. Willard, and W. J. Youden, National Bureau of Standards.

Tensile Cryostat for the Temperature Range 4 to 300 Kelvin—R. M. McClintock and K. A. Warren, Cryogenic Engineering Laboratory, National Bureau of Standards.

A Small Panel Method for Investigating Moisture Penetration and Bond Strength of Brick Masonry—T. Ritchie, National Research Council of Canada.

The Analysis of Stress-Rupture Data with a Minimum Deviation Function—M. J. Stutzman and J. W. Faber, Westinghouse Electric Corp.

A Simple Stress-Corrosion-Cracking Test for Copper Alloys—D. H. Thompson, American Brass Co.

A Study of the Centrifuge Test for Determining the Cement Content of Fresh Concrete—Stanton Walker, D. L. Bloem, R. D. Gaynor and J. R. Wilson, National Ready Mixed Concrete Assn.

Improved Cryostat and Accessories for Tensile Testing at −423 F—J. F. Watson and J. L. Christian, Convair-Astronautics.

Testing Laboratories Directory To Be Reissued by ASTM

THE ASTM is now gathering the information necessary to bring the 1955 edition of its "Directory of Commercial and College Testing Laboratories" up to date. In 1954, the ASTM agreed to assume the responsibility for publishing the directory, which the National Bureau of Standards had compiled and published since 1927. The NBS directory went through five editions at about five- or six-year intervals. This will be the second ASTM edition. The revised directory will list commercial and institutional testing laboratories, together with the kinds of commodities that they test and the types of tests they state they are prepared and qualified to make. Consulting, research, and development laboratories will not be listed, since they are adequately covered by other directories.

The ASTM directory serves as a useful reference for the large number of purchasers who are not equipped to make their own tests and therefore may hesitate to buy on specifications. The knowledge that they can at any time call upon testing laboratories to check deliveries made on standard specifications should induce many purchasers to take full advantage of the specification method of buying.

The data are being collected on a questionnaire recently mailed to all

(*Continued on p. 50*)

ACR NOTES ADMINISTRATIVE COMMITTEE ON RESEARCH

The Mission of ACR

By W. L. DOLCH[1]

A GROUP DISCUSSION was held during the Annual Meeting of the Society in 1959 under the auspices of the Administrative Committee on Research. The purpose of this meeting, to which representatives of the working committees were invited, was to discuss ways in which the ACR could function more effectively. This meeting developed from a general feeling of frustration on the part of the ACR, which was expressed by one member in comparing the ACR with a child who has every advantage, yet fails to blossom as expected. Part of the difficulty turned out to be some confusion over the exact aims of the ACR.

The meeting crystallized these aims. They turned out to be twofold: (1) a reportorial function, and (2) an inspirational function. The reportorial service is one of keeping informed on the many research activities of the working committees and keeping the board of directors informed, in a general way, of the state of research in the Society. This function is comparatively straightforward and presents no special problem to the ACR.

The inspirational function is where the difficulty lies. The essence of this function is the promulgation of the importance of research in the working committees and the facilitation and coordination of this research. The difficulty in fulfilling this function is the root of the frustration felt by the ACR.

Part of this difficulty is a natural reluctance to interfere with the affairs of the working committees. The research ideas should, after all, originate in the committees. Indeed, many are carrying on excellent research activities and need no prodding or assistance from the ACR. The two committees with which I am most familiar, C-1 on Cement and C-9 on Concrete and Concrete Aggregates, are examples

The inspirational function has, therefore, been carried out in the past in several other ways. The ACR has accumulated and published useful information on some unsolved problems of importance in ASTM. The ACR has a certain amount of money at its disposal, with which to finance small research projects that it considers worth-while. Meetings and symposia on research have been sponsored from time to time. The ACR is considering the sponsorship, together with other segments of the Society, of informal, research-in-progress sessions at the Annual Meetings. These sessions would be for the purpose of promoting discussion, rather than formal paper presentation, the only publication requirement being an abstract. A corollary objective would be to interest younger research people in the Society.

But in spite of these activities the feeling persists that the ACR could and should be doing more to influence the research aims of the Society.

Two years ago a column in the ACR Notes got to the heart of the matter. The title of this column, by R. C. Alden, was "Research Comes First." The aims of the Society are the promotion of knowledge of engineering materials and the development of standard specifications and test methods. The basis of this knowledge and these standards must be good research. This has always been true, but perhaps this truth has been obvious only recently, when theory has been chasing experiment in materials work and dropping further behind in many critical areas.

One point that may not have been brought out with sufficient clarity is that materials research, and indeed any research, has a double motivation. It is useful and it is good. The aims of the working committees have perhaps been too closely allied to the utilitarian concept of research. The history of science has been that utilitarian benefits have proceeded most often from activities that were engaged in with other end points in mind or for motives based largely on simple curiosity.

Our standards are full of empirical methods of test that serve a certain function, to be sure, but that are limited by a lack of generality in conception. If the ACR can instill more of the idea that research into the basic properties and behavior of materials will ultimately result in better standards, it will have served its function in the highest sense.

The thought has been expressed that the advent of the new Materials Sciences Division has made the ACR obsolete. I think this is a short-sighted view. The functions of the two groups are, rather, complementary. The aim of the new division is to emphasize the generality of the science of engineering materials. Many aspects of materials have common roots, and these, if I understand correctly, are the province of the MSD. This has nothing to do with research, *per se*. The aims of the ACR should be to develop, by whatever appropriate means, the theme that good research is fundamental to good standards. This research can be applied or basic. It can be sponsored by a committee or undertaken by the members in their own organizations. It does not matter. All that matters is that it be good research. As Mr. Alden said, research comes first.

The ACR is a broker. It cannot operate in a vacuum. That has been part of the trouble in the past. If it can assist in specific projects, well and good. If it can inspire, better yet. It must further the idea that good research is fundamental to good standards.

[1] Purdue University, Lafayette, Ind.

DISTRICT ACTIVITIES

WASHINGTON

Some Aspects of the Space Age

KURT STEHLING, Office of Program Planning and Evaluation, National Aeronautics and Space Administration, speaking before a joint luncheon meeting of the Washington District and Committee E-6 on Methods of Testing Building Constructions, presented an informal review of the developments and programs sponsored by NASA.

The nearly 100 persons present at the Nov. 14 meeting in Washington, D. C., were able to realize much more clearly the great effort being made to advance the position of the U. S. in the science of rockets and missiles, not only for the military but for scientific research. The various types of rocket vehicles were described and illustrated by colored slides, as well as the particular purpose of each.

Prior to his current assignment, Mr. Stehling was head of the Vanguard Rocket Vehicles Branch of NASA, and before that he was head of the Rocket Research and Physics Group of Bell Aircraft Co.

The joint meeting, held at the Shoreham Hotel, was followed by the regular meetings of Committee E-6, ending with a symposium on testing, with papers dealing with curtain wall construction

and related testing programs involving sound transmission loss through structures, insulated flat roof construction, and loading tests on full-scale house roofs.

DETROIT

More than 100 members and guests of the Detroit District of ASTM met in the Rackham Memorial Building, Detroit, Mich., on Thursday evening, November 17, for dinner and a panel discussion on what constitutes a proper, adequate, and legal specification.

Roy P. Trowbridge, director of the Engineering Standards Section of the General Motors Central Office Engineering Staff, served as moderator. Mr. Trowbridge, in pointing out the relationship between specifications and standards, stated that in addition to its mission of assuring technological competance, a specification is also a means of communication.

The legality of specifications and the pitfalls in specifications writing were discussed by Herbert F. Layle, associate professor of industry, College of Engineering and Architecture, University of Detroit. Professor Layle, speaking from a background of law, cited several case examples to illustrate the point that where a specification may be valid in one instance, it may be invalid, or even illegal, in another.

The Ford Motors Company's view with respect to the development of company specifications was discussed by Mr. William A. Bachman, supervisor, Materials and Process Engineering Section, Materials and Equipment Engineering Department of the Manufacturing Staff of Ford Motor Co. Mr. Bachman stated that one of the major reasons for the development of company specifications was to enable the Purchasing Department to obtain competitive bids on a comparable basis. He did point out, however, that before developing its own specifications, a company should determine whether there is an existing, acceptable, industry standard. If not, the company must develop one. The specifications should include what properties must be defined to ensure desired results, what tolerances would be allowable, and what test methods would be used to determine whether the materials meet the specifications.

The final panelist, Mr. George O. Newcomb, chief, Standardization Branch, Engineering Div., United States Ordnance Tank Automotive Command, Detroit, Mich., discussed the military viewpoint on specifications. He pointed out that military specifications are procurement items, and express requirements in terms of performance.

A vigorous discussion period following the panel was brought to a close by Mr. C. F. Nixon, chairman of the Detroit District, at 10:30 p.m. The program was arranged by Rear Admiral L. J. Jacobi, USNR (retired), of The Detroit Edison Co., and a member of the ASTM Administrative Committee on Standards. Admiral Jacoby introduced the new Executive Secretary, Thomas A. Marshall, Jr.

TESTING LABORATORIES DIRECTORY

(Continued from p. 48)

laboratories listed in the previous directory and to laboratories that have asked to be listed in future editions. An effort has been made to send a questionnaire to all laboratories that can be identified from the ASTM membership list. Any laboratory may obtain a questionnaire from Society Headquarters.

ASTM MEETINGS

Date	Group	Place
Feb. 3	Washington District	Baltimore, Md.
Feb. 5–10	Committee D-2 on Petroleum Products and Lubricants	Philadelphia, Pa. (Benj. Franklin)
Feb. 6	Committee E-19 on Gas Chromatography	Philadelphia, Pa. (Society Headquarters)
Feb. 6–8	Committee D-1 on Paint, Varnish, Lacquer and Related Products	Roanoke, Va. (Hotel Roanoke)
Feb. 6–9	Joint ASTM-TAPPI Committee on Petroleum Wax	Philadelphia, Pa. (Benj. Franklin)
Feb. 8–10	Committee D-16 on Industrial Aromatic Hydrocarbons	Philadelphia, Pa. (Benj. Franklin)
Feb. 14–15	Committee B-4 on Metallic Materials for Thermostats and for Electrical Resistance, Heating, and Contacts	Washington, D. C. (Sheraton-Park)
Feb. 16–17	Committee F-1 on Materials for Electron Tubes and Semiconductor Devices	Washington, D. C. (Sheraton-Park
Feb. 21 or 22	Committee D-23 on Cellulose and Cellulose Derivatives	New York, N. Y. (Commodore)
Feb. 23–24	Committee D-6 on Paper and Paper Products	New York, N. Y. (ASA Headquarters)
Feb. 24	Committee D-25 on Casein and Similar Protein Materials	New York, N. Y. (Borden Co.)
Feb. 27	Committee E-13 on Absorption Spectroscopy	Pittsburgh, Pa. (Penn Sheraton)
Feb 27-28	Committee B-9 on Metal Powders and Metal Powder Products	St. Louis, Mo.
Feb. 28–March 3	Committee D-13 on Textile Materials	New York, N. Y. (Sheraton-Atlantic)
March 2	Committee E-2 on Emission Spectroscopy	Pittsburgh, Pa. (Penn Sheraton)
March 6	Central New York District (Joint with Am. Soc. for Metals)	Utica, N. Y.
March 6–8	Committee D-9 on Electrical Insulating Materials	Louisville, Ky. (Sheraton)
March 7	Southeast District	Birmingham, Ala.
March 7–8	Committee F-2 on Flexible Barrier Materials	East Lansing, Mich. (Michigan State Univ.)
March 7–10	Committee D-20 on Plastics	Louisville, Ky. (Sheraton)
March 8	Southwest District	New Orleans, La.
March 9	Southwest District	Houston, Tex.
March 10	Southwest District	Dallas, Tex.
March 11	Southwest District (Joint with Am. Chemical Soc.	Bartlesville, Okla.
March 13	Washington District (Joint with Raleigh Engineers' Soc.)	Raleigh, N. C.
March 23–24	Committee D-14 on Adhesives	Washington, D. C. (Sheraton-Park)
April 5–7	Symposium on Materials and Electron Device Processing (Sponsored by Committee F-1)	Philadelphia, Pa. (Benj. Franklin)

BOOKSHELF

Members who wish to be considered for reviewing books are invited to send in their names and the subjects in which they are interested. Due to customs and mailing considerations, requests from the United States only can be considered. Copies of these books are not available through ASTM; all inquiries concerning them should be addressed to the publisher.

Portrait of a Stormy Forester

Hermann von Schrenk

J. E. Cronin; Cronin, Kuehn, publisher (1960): 274 pp.; $4.50.

Reviewed by L. J. Markwardt, Consulting Engineer, Chairman of ASTM Committee D-7 on Wood, and formerly Assistant Director, U. S. Forest Products Laboratory

IN WRITING this biography only six years after Dr. von Schrenk's death, Dr. Cronin has sacrificed somewhat the perspective of time, but has gained an invaluable asset in the current availability of records and documents that time has not yet effaced; and of contact with former colleagues, associates, friends, and acquaintances who still have vivid recollections of von Schrenk. Out of this wealth of documentary material and personal interviews, Dr. Cronin presents an interesting and fascinating account of the dynamic life and deeds of Dr. von Schrenk. The biography is a splendid example of good literature, and provides an easy-reading account of one phase of the industrial growth of America and the romance of the railway age as revealed through the trail of von Schrenk's activities.

This book is of special interest to ASTM because of Dr. von Schrenk's presidency (1933–1934), his long chairmanship of Committee D-7 on Wood, and other Society activities.

In an over-all appraisal, Dr. Cronin states:

"If von Schrenk had simply supplied the railroads with the information they needed (on selection and preservative treatment of ties) there would have been no occasion for a biography; a few lines in a government pamphlet at the head of his long list of publications would have sufficed. But von Schrenk was an extraordinary individual. His brilliance was almost legendary. His self confidence was gargantuan. His arrogance was colossal. His capacity for work was unmatched. His curiosity was insatiable. As a monologist he was breath-taking.

"Few men in his time wrote so much on so many things, talked so much, visited so many places, made so many friends and implacable enemies. When he chose he could be charm itself, whether sporting the pink hunting coat he loved to wear at his own table, or standing knee-deep in an Arkansas swamp, or holding a roomful of important railroad executives fascinated for hours. In the same day he could also be the most exasperating man in the world."

Dr. Henry Schmitz in his foreword makes this appraisal:

"Doctor von Schrenk was a man of contrasts. His interests were broad and catholic. His conversation was witty and often pungent. His demeanor was often irritating. His facial expression was often stony and pitiless. And yet behind that façade there was the real von Schrenk—the von Schrenk with the kind and understanding heart."

Dr. von Schrenk's career embraced the first half of the twentieth century, when the nation was developing its industrial economy. This covered three periods in the world of forestry: the turn of the century, when we literally had timber running out of our ears; the timber-mining period that followed; and later the beginning of the timber crop era. This period was made for von Schrenk, and von Schrenk was made for the period.

Dr. von Schrenk's training in botany and plant pathology brought him face-to-face with the problem of decay in timber. His practical instinct led him away from the purely academic to the realistic world of decay prevention, in which methods of preservative treatment of railroad ties became a major activity. Dr. Cronin thus colorfully appraises von Schrenk's activities in this field:

"The romance of the railroad has always been the big train; great thundering symbol of our unappeasable hunger for far-away places, it has haunted our folklore and the dreams of our literary men. The track, too, is a symbol, less dynamic but no less familiar; two gleaming parallel lines reaching off toward the horizon with the beguiling promise that they will meet.

"But the railroad tie—what can be said of that?

6″ by 8″ by 8′; 7″ by 9″ by 8′6″

So the specifications read. A rough-hewn chunk of wood, probably the most utterly utilitarian, functionally designed object in the whole range of commerce and industry. And when the tie is ready for the track, thoroughly impregnated with creosote to make it durable, it is even less attractive than before.

"Could a railroad tie conceivably capture the imagination? As a subject does it have any interest? As an object, except as something shoved under a track, has it any importance? The answers to these are yes and yes, and yes again!"

The biography covers a review of the research on controversial features of the characteristics of wood preservatives and the technique of treating wood in which Dr. von Schrenk was particularly engulfed. It is particularly interesting as an historical record of the battlefield of wood preservation. The technical dissertation is a remarkable tribute to the versatile pen of the author.

Johnson had a Boswell to record his deeds and thoughts. Dr. Cronin did not know von Schrenk personally, but with characteristic enthusiasm, perseverance, and study, he has recorded an unusually interesting documented biography. He concludes with this comment:

"He is gone now. With his going went the excitement and the color. Once again a railroad tie is simply a large ugly chunk of wood, and treating it a rather dull and routine procedure. Even those whose hackles rose at the very sound of his name in the convention corridors would, if you asked them straight, admit that things have changed and they would like the old days back. 'The Doctor has made things go!' they say. 'We miss him.' What was this magic?"

Progress in Nondestructive Testing, Vol. 2

Edited by E. G. Stanford and J. H. Fearon; The Macmillan Co., New York, N. Y., (1960); 250 pp.; Illus.; $12.

Reviewed by R. A. Pulk, U. S. Army Ordnance Corps, Detroit, Mich.

THIS is the second in a series of reports on the development of nondestructive testing theory and application. The technology of nondestructive testing is growing so rapidly as to merit a series of this type.

This volume cannot be classified as either a handbook for the technician or a textbook for the scientist. Rather, it is an up-to-date report on various phases of the technology as told in good style by several international experts whose interests and backgrounds vary from research to application. This volume would be of value to anyone interested in the testing, evaluation, and analysis of materials, and especially in the correlation of mechanical or physical properties with parameters defined in nondestructive testing. Various sections of the book are oriented toward the technician, while other sections, of a fundamental or basic nature, are intended as a text for the research worker.

The chapter on radiology with high-energy X-rays is an excellent review written by an authority in this field, and is readily understandable by the technician. On the other hand, anyone interested in engaging in research in high-voltage techniques will find

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this chapter of value. A complete presentation of the latest advances in radiology with high-energy X-rays could not be completely covered in a single chapter of a book of this length. However, the organization of the material, coupled with the extensive references, gives it handbook value. The sections on radiographic techniques with megavolt X-rays, although complete in outline, require that recourse be made to the many references listed if one wishes to have a detailed knowledge of this subject. Such techniques as stereoradiography, stroboscopic radiography, and neutron radiography are only touched upon, but again there are many references.

The chapter on the mechanical testing of high polymers attempts a presentation of the mathematical theory of viscoelastic behavior, a rather difficult assignment in the short space allocated. This section is not oriented toward the technician. However, the experimental section does furnish some insight into polymer properties under stress at various frequencies. The treatments of experimental creep and stress relaxation, free vibration, resonance, and wave propagation are not in the area of nondestructive testing or analysis, since specimen preparation is involved. Also, hardness measurements, by virtue of distortion of the part, would not be categorized as nondestructive testing. However, justification for this type of treatment in a book on nondestructive testing is based upon the interest of the technologist in aligning the properties of materials with various nondestructive testing parameters. This alignment can only be obtained by consideration of such experimental studies. In summary, the treatment of mechanical testing of high polymers is excellent, but certainly not comprehensive. As in the treatment on high-voltage radiography, the references lend considerable value to this section.

The section on application of electrical methods for flaw detection is devoted primarily to resistance changes caused by internal changes in the material; however, techniques involving eddy-current and inductive changes are outlined on a schematic or experimental basis. The portions dealing with phase changes in metals are considered of fundamental value. For example, the austenite-martensite transformation in steel is touched upon in correlating the per cent transformation with resistance changes. A similar treatment is given on the aging of aluminum alloys. The treatments of magnetostrictive resistivity changes, resistivity strain coefficients, and resistance strain measurements, together with the treatment of lattice defect studies by electrical resistivity methods, are essentially fundamental in nature, with a good outline of the results of experimentation and an adequate reference list. This section lends itself more to use by the advanced technologist rather than by an application specialist. This section, together with the section on the studies of aging and precipitation in metals using anelastic damping measurements, is indeed a valuable, fundamental study of the correlation of precipitation and aging properties with physical parameters. It is suggested that these two sections could conveniently have been combined. The discussion on the nature and origin of anelastic damping furnishes a sound and informative insight to the possibility of using this phenomenon in aging studies.

The chapter on defect assessment by ultrasonics is essentially restricted to the latest developments in the pulse-echo technique and to the comparison of the pulse-echo signal with standard known defects in a reference block. This is indeed a difficult assignment, to which many workers in this field are now devoting effort. This section does not take advantage of existing reference or test blocks such as that recommended by the International Institute of Welding. The lack of such treatment, together with the near exclusion of all but the pulse-echo technique, result in a section of limited scope in ultrasonics. However, the author succeeds in explaining and pointing out the limitations of the pulse-echo technique in defect assessment by the use of comparison reference blocks. Such factors as test block design, echo indication influences, and beam and probe characteristics are explained concisely and clearly. The treatment of the accuracy of the test block method points out clearly the effect of defect orientation on the accuracy of the pulse-echo technique. This chapter presents an easily grasped outline of the pulse-echo uses and limitations to the technician.

The chapter on the application of paramagnetic resonance to nondestructive testing illustrates the results that can be achieved with specific experimental examples. By explaining the fundamentals of the process involved and by recourse to sound references, the author furnishes the reader with a very valuable insight to the possibilities and shortcomings of this technique. The tone of the section is necessarily tentative and suggestive in nature; but the well-outlined fundamentals, together with the source material furnished in the list of references, result in an extremely valuable treatment of the technique of paramagnetic resonance.

In the chapter on radioactive isotopes, a good presentation of basic principles involved in radioisotope techniques is given. In particular, the explanations of particle production and emission, radioactive isotopes, and absorption techniques are recommended as sound source material for the technician. Considerable attention is given to thickness gage measurement. By far the most complete and exhaustive treatment is given tracer applications in filter flow and leak detection. A complete bibliography and reference source list is included with this chapter.

Generally speaking, this work runs the spectrum of applicability from the technician to the scientist and technologist. On this basis, it can be considered a rather valuable adjunct to the nondestructive testing library, not essentially as a handbook but as a reference work for the analytical evaluation of technique. Certainly, anyone possessing this book will look forward to the publication of subsequent volumes taking advantage of the many continuous advances in nondestructive testing.

The Surface Chemistry of Metals and Semiconductors

Edited by H. C. Gatos, assisted by J. W. Faust, Jr., and W. J. LaFleur; John Wiley & Sons, Inc., New York, N. Y. (1960); Illus.; 526 pp.; $12.50.

Reviewed by Erle I. Shobert II, Stackpole Carbon Co., St. Marys, Pa.

THIS BOOK includes papers and discussions presented at the Joint Symposium on the Surface Chemistry of Metals and Semiconductors sponsored by the Corrosion and Electronics Divisions of The Electrochemical Society, Inc., in Columbus, Ohio, October, 1959.

Most of the contributors are working at the forefronts of their various fields, and their contributions in most cases point the way to further investigations and delineate the problem areas. From this standpoint, the discussions, which are presented in complete form, are an outstanding part of the publication. The papers are combined into five groups:

Part I—*Chemistry and Physics of Surfaces* deals with the problem in general and discusses clean surfaces, the electronic properties of metal surfaces, and the electrical properties of semiconductor surfaces.

Part II—*Imperfections and Surface Behavior* discusses primarily the constitution of damaged surface layers (for instance the Bailby layer), and the effect of dislocations and imperfections on the chemical reactions of metals and semiconductors.

Part III—*Electrode Behavior of Metals and Semiconductors* discusses this problem in general, and gets into details of the etching processes.

Part IV—*Surface Reactions in Liquid Media* discusses primarily the dissolution of metals and semiconductors in aqueous solutions.

Part V—*Surface Reactions in Gaseous Media* considers adsorption, chemisorption, catalysis, the mechanism of oxidation of metals including the condition for protective layers, and the influence of crystal orientation on oxidation rates.

It is apparent that the papers and discussions have been carefully prepared. The references are pertinent, and the editing has been careful and consistent. This book should be of considerable help to anyone concerned with the state of knowlege in the areas mentioned above.

Physical Metallurgy

Bruce Chalmers; John Wiley & Sons, Inc., New York, N. Y.; 368 pp.; illus.; $12.50

Reviewed by Morris Tanenbaum, Bell Telephone Laboratories, Murray Hill, N. J.

THE LAST several years have seen the emergence of a new point of view in the approach to the subject of physical metallurgy. Earlier in this century the explosive development of the science of chemistry had an impact upon the field of metallurgy which revolutionized both the science and technology of metals. Shortly after World War II an equally vigorous development in the field of solid-state physics occurred. This latter development has recently begun to have its full impact on physical metallurgy. One does not expect revolution without controversy, and, indeed, there is much discussion and controversy, especially among educators, concerning the methods by which this new science should be absorbed into the traditionally descriptive subject of physical metallurgy. This new text by Bruce Chalmers is a true phenomenon of the revolution that is taking place in the science of metals.

In his preface, the author expresses the opinion that physical metallurgy as a scientific rather than a descriptive subject can be best introduced to the student after his knowledge in the basic sciences has been built to a rather advanced level. This statement is a clue to the contents of the text, which endeavors to approach the admittedly complicated behavior of metals from first principles. It is the reviewer's opinion that the author's success in this endeavor is a further demonstration of the power of the application of fundamental physical and chemical principles to the understanding of metallurgical phenomena.

In approaching his task the author has found it necessary to limit the depth of certain parts of his presentation in order to achieve the necessary scope. He warns the reader that a moderate background in modern chemistry and physics is a prerequisite to the full use of this text. Although the first two chapters are devoted to a description of the structure of the atom and the behavior of aggregates of atoms, the treatment in these chapters has been so limited that this material serves only as a review and would be difficult reading for one who has no familiarity with these subjects. The author has also found it necessary to speak very concisely about the structure-insensitive properties of metals, and the 14 pages devoted to these subjects can serve only to define the properties and indicate to the reader other areas which he may wish to pursue in other texts.

The remaining five chapters constitute the heart of this work. They are devoted to the structure-sensitive properties of metals which make them so important in modern technology and whose control provides the greatest challenge to the metallurgist. It is in these chapters that Professor Chalmers' talent as a teacher and his technique as an editor are best demonstrated. The organization of the subject matter is excellent and the development of the discussion of these complicated aspects of metals is usually lucid and carefully developed. Chapter 4 introduces the subject of imperfections in crystals, and Chapter 5 discusses the manner in which these concepts have been used to explain the structure-sensitive properties of metals. Chapter 6 is devoted to the phenomenon of change of state. Here the processes of solidification are discussed. Professor Chalmers has been one of the leading contributors to the scientific understanding of solidification processes, and this chapter is especially authoritative in describing the mechanisms of solidification as developed by the Chalmers school. The remaining two chapters are devoted to deformation, radiation damage, recovery processes, and solid-state transformation. The same theme of explaining macroscopic phenomena from a microscopic and atomistic point of view is retained.

Although there is a continued insistence upon a discussion of fundamental mechanisms, there is a continued and successful effort to relate these mechanisms to technologically important phenomena. For example, the discussion of the mechanisms of solidification includes frequent reference to the observed structure of castings, and attempts are made to explain the operation of the methods currently used to control the structure of castings. In another instance the current understanding of the mechanisms of solid-state transformations is used wherever possible to explain how the heat treatment of ferrous alloys succeeds in producing the structure and properties that are so important technologically.

This book is certain to be given an interesting reception. Certainly there are aspects from which it can be criticized. Teachers who select it as a text will find it necessary to supplement it with other sources. For example, there is no discussion of such an important technique of physical metallurgy as X-ray diffraction. This is a deliberate omission, as the author states in his preface, where he cautions the reader that supplementation will be necessary, and certainly it would not be possible to do justice to all the aspects of metals in a single volume. Others may feel that the approach is too qualitative. For example, much of the mathematics of dislocation theory has been omitted. Although this omission contributes substantially to the ease of reading, the process of learning would be better stimulated by the discipline of some mathematics. On the whole, however, this reviewer feels that Professor Chalmers has made a very useful and interesting contribution to the pedagogy of physical metallurgy. He has fulfilled his purpose of providing a text that will be useful in an introductory course of physical metallurgy as well as that of producing a very readable volume for the practicing metallurgist who wishes to refresh his understanding of recent ideas in his field. In addition, this book is certain to serve as a source of inspiration for future authors as physical metallurgy develops more and more clearly into the physics of metals.

(*Continued on p. 77*)

NEWS OF MEMBERS

The Portland Cement Assn. at its Annual Meeting in Chicago elected new officers and directors, several ASTM members being among them. **H. A. Sawyer,** chairman of the board and president, Lone Star Cement Co., New York, N. Y., was elected chairman of the board of directors; **H. R. Schemm,** president, Huron Portland Cement Co., Detroit, Mich., was elected a director; **Richard A. Grant,** president, California Portland Cement Co., Los Angeles, Calif., and **R. D. Raff,** president, Diamond Portland Cement Co., Middle Branch, Ohio, were re-elected directors for an additional two-year term.

James H. Bly, Sales Div., High Voltage Engineering Corp., Burlington, Mass., is now director of science applications.

Robert G. Bowman, Jr., is associated with The Procter & Gamble Co., Cincinnati, Ohio, as process engineer. He had been research engineer, E. I. du Pont de Nemours & Co., Newburgh, N. Y.

George L. Buc, Fisher Scientific Co., Pittsburgh, Pa., and Frederick Strong III shared the 1960 Medal Award of the Society for Applied Spectroscopy, New York Section, for their outstanding contributions to the journal, *Applied Spectroscopy*.

Arthur Colton, formerly engineering standards administrator, American Society of Tool and Manufacturing Engineers, Detroit, Mich., is now administrative engineer, Bendix Industries, Controls Section, Detroit, Mich.

William R. Dana is now technical director, American Pipe and Construction Co., Los Angeles, Calif. Formerly he was chief engineer, Amercoat Corp., South Gate, Calif.

Charles R. Delott is an engineer with United States Gypsum Co., Chicago, Ill. He had been engineer, Sprague Electric Co., North Adams, Mass.

Leon V. Foster has retired as head, Military Engineering Dept., Bausch & Lomb Optical Co., Rochester, N. Y. A member of the Society since 1932, Dr. Foster has been active in Committees E-4 on Metallography, D-20 on Plastics, A-3 on Cast Iron, E-12 on Appearance, D-13 on Textile Materials, and the Western New York–Ontario District Council.

(*Continued on p. 61*)

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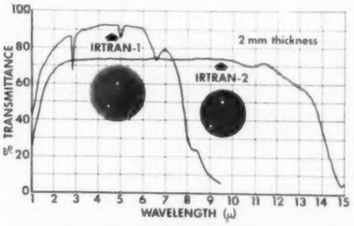

Kodak Irtran merchandise: an *Irtran-1* dome and an f/1.0 *Irtran-2* molded asphere

There are now two kinds of *Irtran* optical material, neither of them intended for wavelengths that your old dictionary would call "optical."

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*Irtran-1** material, the other one, needs no anti-reflection coating because its refractive index is only 1.38 at 1μ. *Its* big glory, aside from high infrared transmittance at 2 to 7μ even when very hot, stems from a 9.4 kmc dielectric constant of 5 and a loss tangent of 10^{-4}.

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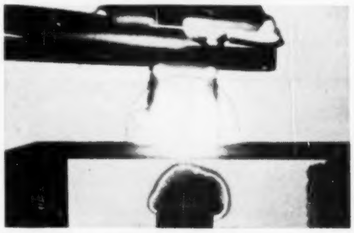
Eastman Chemical Products, Inc., our subsidiary, sells the resin. Acme Backing Corporation, Canal and Ludlow Streets, Stamford, Conn., turns it to what others call film and we (for whom "film" has another meaning) call sheeting. Acme will gladly expatiate.

*Formerly designated "Irtran AB-1."

Favor for the high-speed congress

Dust Performs for Plant's Pollution-Control Movies, *Chem. Week*, 84:84,86, May 2, 1959. (Procter & Gamble uses high-speed motion-picture sequences for the qualitative control of in-plant dust.)



The Ignition of Explosives by Radiation, J. Eggert, *J. Phys. Chem.*, 63:11-15, Jan., 1959; also in *Photochemistry in the Liquid and Solid States*, edited by F. Daniels, J. Wiley, N. Y., 1960, pp. 147-53. (High-speed photography proves that the detonation of nitrogen iodide starts before the light flash ends, showing that only a fraction of the energy is used for the detonation.)

Lathe Check Formation in Douglas-fir Veneer, *Forest Products J.*, 10:139-40, March, 1960. (High-speed motion pictures were used to analyze production variables.)

Time after time we have visited a customer proud of some accomplishment with high-speed movies. He is willing to show us—eager, delighted to show us. The projector is started and we watch. We see a collection of strange objects. We don't know for sure what they are. Little seems to be happening. After quite a while, a new object enters the scene from the left. Shortly another new object comes up from the bottom. The two dance around each other, touch, and exit from the top of the frame. All is again static on the screen. After another while the reel comes to its end and we jump to our feet exclaiming hearty congratulations.

He deserves congratulations, probably. If we had lived with the problem as he has, the objects in the picture might have seemed no stranger than the face in the bathroom mirror; the dance might have been the triumphant, forceful, sudden, undisputed clincher to a vexatious problem; the all-purpose enthusiasm of the born salesman might have meant more.

Nevertheless, we need not be ashamed. We help scientists and engineers use high-speed photography by manufacturing a group of films to the stringent mechanical requirements of high-speed cameras. *Kodak Plus-X Reversal Film* we make for reversal processing to a fine-grain positive. *Kodak Tri-X Reversal Film* is four times as fast. *Kodak Double-X Panchromatic Negative Film*, which is a bit faster yet and very sharp, is picked when a quick negative will suffice or when several prints may be wanted later. *Kodak Royal-X Pan Recording Film* is picked only when light is very limited indeed; *Kodak Linagraph Ortho Film*, for accentuated sensitivity to green light; *Kodak High Speed Infrared Film*, for sensitivity to 9000A, with a maximum from 7700A to 8400A; *Kodachrome Film*, for color, with low-cost commercial processing widely available; *Ektachrome ER Film*, for color at exposure index of 160 or higher.

Another thing. A bibliography on high-speed photography. Every item our library knows. Forty-six pages of items like the specimens at the immediate left. No pictures, though. No charge either. Coverage extends into 1960. Got it ready to distribute to the Fifth International Congress on High-Speed Photography in Washington in October. Doomed to a short life, since the Congress promptly generated so many *new* papers on high-speed photography that the abstracts alone run from p. 609 to p. 682 of the September, 1960, issue of the *Journal of the Society of Motion Picture and Television Engineers*.

Eastman Kodak Company, Photorecording Methods Division, Rochester 4, N. Y., would be glad to send the bibliography or answer questions about the above-named films.

This is another advertisement where Eastman Kodak Company probes at random for mutual interests and occasionally a little revenue from those whose work has something to do with science

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NEWS OF MEMBERS

(*Continued from p. 53*)

J. M. Hait has been elected president, Food Machinery and Chemical Corp., San Jose, Calif. He had been executive vice-president.

W. F. Markley recently retired from The Western Union Telegraph Co., New York, N. Y. For a number of years Mr. Markley represented his company on Committees B-1 on Wires for Electrical Conductors, A-5 on Corrosion of Iron and Steel, D-11 on Rubber and Rubber-Like Materials, and D-9 on Electrical Insulating Materials.

Ignacio Martin-Belmonte, formerly inspection engineer, Laboratorio de Ensayo de Materiales, Universidad de la Habana, Havana, Cuba, is now with Sacmag of Puerto Rico, Inc., Santurce, Puerto Rico, consulting engineers.

Charles L. Matz retired December 31, 1960, from the Commonwealth Edison Co., Maywood, Ill., having served in various capacities for approximately 40 years. Mr. Matz will continue to participate in the activities of Committee E-5 on Fire Tests of Materials and Construction through individual membership in the Society.

A. R. McLerran is now a consulting engineer with A. R. McLerran and Associates, Beaumont, Tex. He had been chief development engineer, IDECO Div., Dresser Equipment Co., Beaumont, Tex.

Olin W. Mintzer, associate professor of civil engineering, Ohio State University, Columbus, Ohio, recently read his research paper on using aerial photographs to identify construction sources of gravel before the Ninth International Congress of Photogrammetry at the University of London, England. Professor Mintzer made the point that the use of aerial photographs may determine whether a contractor makes a profit on some highway projects.

William C. Mohr has been promoted to chief ceramic engineer of the Mosaic Tile Co., Zanesville, Ohio Previously he was associated with Shenango China, Inc., New Castle, Pa., as manager of ceramic technology.

Paul P. Mozley, a member of ASTM since 1947, has retired from Lockheed Aircraft Corp., Burbank, Calif. Mr. Mozley was an active member of Committee B-7 on Light Metals and Alloys, Cast and Wrought, and Task Group 6 of Committee E-1 on Methods of Testing.

Malcolm H. Nickerson is now director of research, Construction Co., Suffolk, Va. Previously he served in the same capacity with Lexsuco Inc., Solon, Ohio.

Rudolph E. Peterson, manager, Mechanics Dept., Westinghouse Electric Corp., Pittsburgh, Pa., and past director of ASTM, was awarded the Machine Design Medal by The American Society of Mechanical Engineers. Mr. Peterson won the medal for eminent achievement in his field.

Harry E. Rapp, formerly technical director, Miracle Adhesive Corp., Insul-Fil Div., Bellmore, N. Y., now holds the same position with Tufflite Plastics Inc., Ballston Spa, N. Y.

Robert T. Reinsch, previously mechanical engineer, section head, Florida Tile Industries, Inc., Lakeland, Fla., is now sales engineer, Holmes Co., Lakeland, Fla.

Frederick N. Rhines, professor of metallurgy, College of Engineering, University of Florida, Gainesville, Fla., was the co-recipient of the Henry Marion Howe Medal with John B. Clark, research engineer, Dow Chemical Co. This honor was presented by the American Society for Metals.

Harold B. Staley, previously laboratory supervisor, Mesa Plastics Co., Los Angeles, Calif., is associated with Mobay Chemical Co., New Martinsville, W. Va., as senior chemist.

Willis F. Thompson, vice-president, Westcott and Mapes, Inc., New Haven, has been elected president, United Engineering Trustees, Inc., New York, N. Y.

Albert C. Zettlemoyer has been named Distinguished Professor of Chemistry at Lehigh University, Bethlehem, Pa. Dr. Zettlemoyer represents the National Printing Ink Research Inst. in Society membership.

DEATHS

R. P. Anderson, former secretary of the American Petroleum Institute's Division of Refining, New York, N. Y. (November 26, 1960). For more than 20 years, Dr. Anderson was active in committee work, his main interest being in Committee D-2 on Petroleum Products and Lubricants. He was secretary of this committee from 1925 to 1945, and in recognition of his long and faithful service the committee elected him to honorary membership in 1945.

Theodore I. Coe, Technical Secretary, The American Institute of Architects, Department of Education and Research, Washington, D. C. (November 12, 1960). Mr. Coe, an eminent architect, and chairman of the District of Columbia's Board of Zoning Adjustment for 20 years, supervised the construction of the Supreme Court Building and was employed on many major apartment and industrial projects. He was a member of AIA since 1922, being advanced to Fellow in 1953. His activities in ASTM date back to 1936 and include participation on most of the committees concerned with building materials.

Mr. Coe served as chairman of Committee C-12 on Mortars for Unit Masonry from 1944 to 1950; chairman of Committee C-18 on Natural Building Stones from 1938 to 1940 and as vice-chairman from 1940 up to his death. Committee C-15 on Manufactured Masonry Units elected him to Honorary Membership in 1938, and Committee C-11 on Gypsum bestowed this honor upon him in 1960. In recognition of long-time, faithful service and leadership in varied technical committee work, Mr. Coe was presented with the ASTM Award of Merit in 1958. Mr. Coe also served as Secretary of the Washington, D. C., District Council from 1947 to 1950, and was active on several sectional committees of the American Standards Assn. He served as chairman of Sectional Committee on Specifications for Plastering, A 42, from 1945 until his death.

H. V. Churchill, former chief of Analytical Chemistry Division, Aluminum Company of America, New Kensington, Pa. (November 6, 1960). Mr. Churchill, prior to his retirement in 1951, was active in ASTM committee work for many years, having served as chairman of Committee E-2 on Emission Spectroscopy from 1932 to 1946.

Earl J. Felt, Portland Cement Assn., Skokie, Ill. (November 13, 1960). Mr. Felt represented PCA on Committees D-18 on Soils for Engineering Purposes and E-17 on Skid Resistance.

George Sachs, director, Metallurgical Research Laboratories, Syracuse University Research Inst., Syracuse, N. Y. (October 29, 1960). Dr. Sachs joined the Society in 1954 and was a member of the Central New York District Council.

MATERIALS AND TESTING TOPICS

This information is based on literature and statements from apparatus manufacturers and laboratory supply houses. The Society is not responsible for statements advanced in this publication.

FOR THE LABORATORY

Glove Box—Natural-color, airtight, linear polyethylene glove boxes, designed to eliminate inherent problems encountered with metal-type boxes are now available. The plastic units withstand high-level acids and solvents, while the surfaces of the plastic, both internal and external, are smooth and free from porosity.
American Agile Corp. 3584

Elaidyl Alcohol—Elaidyl alcohol, *trans*-octadec-9-enol, the trans isomer of ordinary oleyl alcohol, is now available in 99 per cent purity in laboratory quantities. Small quantities have been made for use as a gas chromatography standard, and the material is also being used in research on the electrical properties of its crystalline forms.
Applied Science Laboratories, Inc. 3585

Oscilloscope—A null balance technique, used for the first time in an oscilloscope, introduces accuracy and speed for measuring analog data directly from the screen of the new Analab Type 1100/700 oscilloscope. To avoid the usual reading errors from the cathode-ray tube screen, the Analab null-readout system incorporates an anti-parallex scale, equivalent to a mirror-backed scale on a meter.
Analab Instrument Corp. 3586

Temperature Control System — A unique, elevated-temperature platinum resistance thermometer, sealed to avoid contamination by gases, is used with an electronic controller of novel design to operate a saturable reactor for continuously variable power output to the furnace windings. The A + CNS systems are complete, requiring no further equipment to control furnaces of between 100-w and 100-kva capacities for long periods within 0.2 C at any temperature up to 1200 C or 2200 F, from an unstabilized power supply.
Atkins Technical, Inc. 3587

Comparator Screen—A G Life Line is the commercial name of a new optical comparator screen that offers many advantages where close-checking tolerances are a must. Line quality and stability are conventional type glass charts, and there is no reason to replace charts due to worn-out lines, according to the manufacturer. Charts can be cleaned hundreds of times with no weakening of lines.
Automation Gages, Inc. 3588

Strain Gage—First of a new series of subminiature modular input conditioning equipment is introduced. Model 1-202AM has been designed to fit in with the current trend toward standardization of transducers. This instrument will cancel the effects of long lines by utilizing the six-wire, single-shunt calibration technique. It can accommodate several active arms (1, 2, or 4).
B & F Instruments, Inc. 3589

Vacuum Pump—A new, single-stage mechanical vacuum pump combining quiet, vibrationless operation with high speed and low ultimate pressure has been announced. The new S14 pump, designed for general-purpose, high-vacuum applications in industry, research, and laboratories, is especially recommended as a backing pump for oil or mercury diffusion pumps.
Central Scientific Co. 3590

Dynamometer—These testers will test induction motors from the no-load speed to pull-up torque. The unstable section lies between maximum torque and pull-up torque and cannot normally be tested by standard absorption dynamometers. It is important that this section be tested on shaded-pole and multi-speed fan motors.
John Chatillon & Sons 3591

Environmental Test Machine—The new Dynatest machine provides advanced cycling in fatigue testing specimens or structures under compression-tension and elevated-temperature conditions. It is capable of cycling up to 20 cps or above,

and of following a typical programmed heating rate of 200 F per sec. The maximum heating rate depends upon the configuration of the specimen.

CompuDyne Corp. 3592

Thermometer—A new vapor-pressure thermometer for high-accuracy determination of temperatures over small spans in the low-temperature regions has been announced. The sensing element is a sealed system filled with a volume of an appropriate gas such as helium, oxygen, or hydrogen. Gas in the sensor is liquefied when the region of temperature interest is reached, establishing a direct relationship between the internal vapor pressure of the thermometer and the temperature of the sensor.

Cryogenics, Inc. 3593

Transducer—Continuous, accurate, and reliable monitoring of gas and liquid pipe lines through printed records and warning alarms is possible with a new series of digital pressure transducers. Called the DX-100 series, they indicate in digital form the magnitude of pressure inputs. The output of any transducer is suitable for entry into recording devices such as printers, card punches, tape punches, and light banks.

Datex Corp. 3594

Cylinder Tester—New Model QC-225-PC compression machine of 400,000-lb capacity is 100 per cent power-operated, and the usual manually operated pump is eliminated entirely. Featuring the new power control unit, the new pump permits very rapid traverse for fast preloading, and a precise adjustment of the rate of loading so that AASHO and ASTM specifications for rate of loading can be followed exactly.

Forney's, Inc 3595

Ionization Gage—A new recording ionization gage with logarithmic output, which permits measurement of vacuum from 10^{-3} to 10^{-10} mm Hg on a single scale without range changing has been announced.

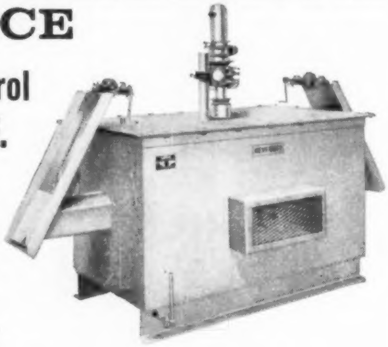
The Fredericks Co. 3596

Strain Gage—A new semiconductor strain gage technology is having the same effect on the stress analyst and transducer designer that the birth of the transistor had on the circuit designer. These new types of strain gages provide all the desirable characteristics of conventional strain gages but are more versatile and provide significantly higher outputs. In addition to their large output, the gages lend themselves very well to the measurement of high-frequency phenomena. A four-arm semiconductor strain gage bridge will provide outputs in the order of 100 mv at total deflections of 50 millionths of an inch. This provides natural frequencies in excess of 100 kc.

Kulite-Bytrex Corp. 3597

Power Supply—A new auxiliary power supply unit for use with the gamma-radiation area monitor is announced. The monitors are used as an automatic alarm system in any area where gamma radiation is present from stored or processed fissionable materials. Designated as Model

(*Continued on p. 66*)



FOR THE LABORATORY

(*Continued from p. 65*)

PSA-11, the auxiliary supplies power to the GA-2 gamma monitor in the event of failure in the primary 100-v source.
Nuclear Measurements Corp. **3598**

Dialyzers—A new, large-volume, self-agitating dialyzer has been announced. Designated Model C, the unit is particularly useful in equilibrating large samples for subsequent electrophoresis. As much as 3½ liters can be treated at one time against a buffer volume of as much as 11 liters for either equilibrium dialysis or concentration dialysis.
Oxford Laboratories **3599**

Transducer—A new dc-output, variable-reluctance, differential-pressure transducer is now available. Its unique ac-dc input circuit permits operation from either the 115-v line or 28-v dc. The Model CP53D is capable of extremely low differential-pressure measurement in the presence of line pressures up to 5000 psi, with the accuracy required for laboratory and industrial measurement. Pressure ranges of the new instrument are from ±0.1 to ±2500 psi.
Pace Engineering Co. **3600**

Potentiometer — The Goerz Model AE5075 microvolt potentiometer has a range from 0 to 1110 μv with a resistance of 100 ohms per μv. The power source used is a built-in saturated standard cell. The potentiometer is designed to compare two voltages which are within 0.1 per cent of each other to within 1 μv directly.
Physics Research Laboratories **3601**

Flexible Sheeting Cutter—The specimen cutter has been designed specifically to produce test specimens with straight, parallel edges, free from nicks, uncut areas, and other imperfections. This is accomplished by a slitting operation, in which any shear effects are negligible. It can be used on flexible plastic rubber, paper, or textile film and sheeting in a broad range of thickness—from less than 0.0005 in. to greater than 0.025 in. For versatility in operation, as many as eight 1-in. strips or 16 ½-in. strips can be prepared simultaneously. If desired, however, specimens of several widths in ½-in. multiples can be produced for many types of tests including tensile, tear, torsion, and impact.
Plas-Tech Equipment Corp. **3602**

Radiography Cameras—An inexpensive line of iridium-192 cameras for industrial radiography has been announced. A family of five Model 192 machines have capacities of 10, 25, 35, 50, and 100 c of iridium-192, respectively, with weights ranging from 50 to 100 lb. They are designed primarily for panoramic and internal radiography, where the machine is used to position the source as required.
Radionics, Inc. **3603**

Oscillograph—Oscillographic recording in a variety of locations is made easier by the mobile Model 297 two-channel oscillograph. This complete recording system,

(*Continued on p. 68*)

Five Reasons Why More Load Calibrations Are Made With Morehouse Instruments Than With All Others

1. PROVING RINGS — The Morehouse Proving Ring is by far the most widely used and accepted instrument for calibrating physical testing machines, thrust stands, dynamometers and other forces measurement equipment. The reason for this is elementary . . its basic simplicity assures highly accurate retention of original calibration for long periods of time. Consisting simply of an elastic steel load ring and a vibrating reed-micrometer screw deflection measuring system, it is unsurpassed as a transfer standard because of its dependable repeatability. With moderate care, the Morehouse Proving Ring will perform well within its specification limits of 1/10 of 1% for years. Every one is calibrated and certified by the National Bureau of Standards to their specification, LC-822.

To further facilitate the use of the Proving Ring, an electrical reed vibrator powered by a self-contained mercury cell is now available for easy installation on new and existing instruments. This vibrator helps even the most inexperienced operator achieve greater accuracy through more consistent dampening of the reed. Since the vibrator's action dampens out at very slight pressure, it increases the ultimate accuracy of the Proving Ring due to heightened sensitivity.

2. CALIBRATING SYSTEMS — The Morehouse Calibrating System provides a high degree of accuracy to remote operation and indication. It consists of a steel load ring with a diametrically-mounted differential transformer and an electronic balancing instrument. Unlike other electronic systems, however, it does not depend on the measurement of electrical signals. The electronic system serves only as a means of transferring the force signal (deflection of the load ring as sensed by the differential transformer) to a micrometer screw contained in the balancing instrument. This feature eliminates the possibility of any inaccuracies which may be magnified or diminished in the instrument circuit. Calibration readings are made by turning the micrometer screw dial until a null-balance is achieved—as indicated on a precision null-balance meter.

Every Morehouse Calibrating System is calibrated by the National Bureau of Standards and provides accuracies well within 1/10 of 1%. The balancing instrument may be teamed with various capacity load rings for a broad calibration range.

3. RING DYNAMOMETERS — The Morehouse Ring Dynamometer is an easy-to-use instrument for checking Brinell hardness testers, certain universal testing machines, presses and other force measurement systems. It consists primarily of a load ring with a precision dial indicator to show deflection. Because of the limitations of dial indicators, accuracies of 1/10 of 1% of range are only assured at pre-calibrated loads. Normally, ten loads in increments of 1/10 of capacity are calibrated by the National Bureau of Standards. However, special loads can be calibrated to meet specific requirements.

4. UNIVERSAL CALIBRATING MACHINES — The Morehouse Universal Calibrating Machine facilitates the calibration of load cells which can not be accurately calibrated in their normal operating position. The Calibrating Machine provides a highly accurate method for applying force to a load cell and a proving ring simultaneously. The force is produced by a precision, two-speed pump especially designed for calibration work.

The entire Calibrating Machine has been designed solely for accuracy. The free-moving yoke completely eliminates friction between the proving ring and the load cell. The Machine and its accessories assure axial loading, too, as non-axial loading contributes to inaccuracies.

A recent innovation, an adjustable yoke, compensates quite simply for various size load cells. It also facilitates the lifting of the yoke and load cell during set-ups.

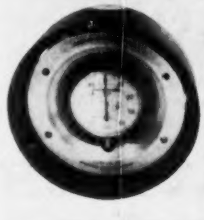
5. SPECIAL APPLICATIONS — Many companies have called on us to apply our long-grained experience to special load calibration problems. In some instances, we have developed systems for permanent installation where highly accurate force measurements or continual calibrations were required. Also in keeping with our leadership and service in the field, we will have a 1,000,000-pound proving ring available on a rental basis shortly after the National Bureau of Standards' new 1,000,000-pound dead-weight machine is operable.

For complete information on these instruments or help on special force measurement and weighing problems, write to:

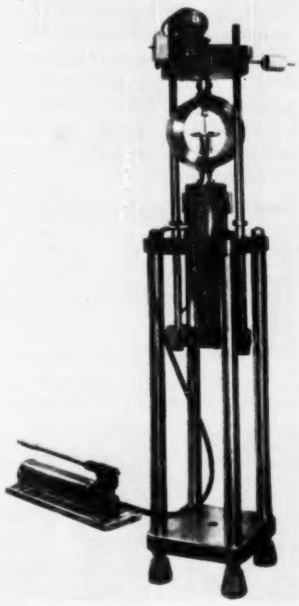
MOREHOUSE MACHINE CO.
1742 Sixth Avenue, York, Pa.

PROVING RINGS

CALIBRATING SYSTEMS



RING DYNAMOMETERS



UNIVERSAL CALIBRATING MACHINE

FOR FURTHER INFORMATION CIRCLE 899 ON READER SERVICE CARD

FOR THE LABORATORY

(*Continued from p. 66*)

which uses plug-in, interchangeable "850" style preamplifiers, is housed in a 35-in.-high wheel-mounted gray steel cabinet that permits easy movement between rooms or into and out of elevators.
Sanborn Co. 3604

Pulse Generator—Production of a pulse generator combined with a synchroscope into a single compact unit is announced. Designated PGB-1 radar pulse generator, the purpose of the new piece of test equipment is the generation of rectangular voltage pulses while providing the built-in means by which they may be observed and accurately measured.
Schaevitz Engineering 3605

Experiment Controller—A new device called Burd-Watcher II for automating, programming, monitoring, and controlling reactions and distillations of any size is announced. Reactions may be controlled above ambient temperature with heaters, or below ambient temperature with coolant solenoids activated as required.
Scientific Glass Apparatus Co., Inc. 3606

Test Gage—A large 14-in.-diameter, eye-ease green dial with white increments, a completely new innovation in pressure test gages, permits "at-a-glance" pressure readings. Available in ranges from 0 to 15 to 0 to 10,000 psig, precision test gages are especially recommended for critical fluid or pneumatic pressure applications.
Seegers Instrument Co. 3607

Cutting Dies—Three dies are manufactured to ASTM dimensions and feature the original "NAEF" expulsion, which provides for more economical and careful sample preparation than are experienced with conventional dies. Dies are available for the crease test (D 1295–53 T); Elmendorf tear resistance test (D 1424–59) (will cut sample with notch and slit in one operation); and the test for tear resistance of rubber D 624–54.
SMS Instrument Co. 3608

Dust-Free Cabinet—The new Model B Specialaire cabinet is an inexpensive, dust-free illuminated work chamber for standard work benches for use in cleaned and non-cleaned areas. The unit is designed to provide high dust arrestment.
Specialties, Inc. 3609

Absorption Tester—The Vanceometer tester is designed to evaluate in numerical terms the absorption rate of sheet surfaces and forecast printability. It provides a means of maintaining quality control of the printing characteristics required of paper and paperboard. It also forecasts the rate of absorption of other media such as adhesives, starches, sizes, inks, etc.
Testing Machines, Inc. 3610

Oven—A new line of "cold wall" (water-cooled shell), high-vacuum bake ovens capable of operating continuously at any temperature within the ranges of 0 to 500 C and 0 to 800 C has been developed. The temperature uniformity within the work zone is held to within ±3 C.
Tri Metal Works, Inc. 3611

NEW LITERATURE

Instrument Catalog—A 56-page catalog describes measurement and control instruments available from Austria.
The Austrian Trade Delegate 6354

Pycnometer—The new Model 930 air comparison pycnometer is described in a *Brochure No. 786* recently published. Rapid, nondestructive volume measurements for density and porosity determinations of irregular, powdered, and porous solids are now possible with the new Beckman instrument. The device is completely hand-operated and requires no power source.
Beckman Scientific and Process Instruments Div. 6355

Metallurgical Apparatus—New 8-page brochure on metallurgical apparatus is now available. Illustrated and described are such laboratory machines as cutters, grinders, mounting presses, portable and table-mounted polishers, and electrolytic etchers and cleaners.
Buehler, Ltd. 6356

Temperature Chambers—New 4-page folder describes 1 to 10 cu ft units especially designed for laboratory and job-shop applications where temperatures from −150 to +300 F are required. Space-saving, low-cost mechanical units are pictured, along with accessories and special controls.
Cincinnati Sub Zero Products 6357

Power Supplies—*Bulletin PT 214.1* lists specifications and features of six new models of power supplies for strain gages. Continuously variable output ranges are from 0 to 30 v and 0 to 200 ma at input of 117 (95 to 135) v, 60 cps. Each model is completely transistorized. The bulletin lists all specifications, including the noise level across a grounded 350-ohm bridge of 1.00 μv peak-to-peak.
Computer Engineering Associates, Inc. 6358

Oscillograph—A four-page *Bulletin No. 5124* containing photos and specifications describes in full the operation of a new, low-cost, portable recording oscillograph now available.
Consolidated Electrodynamics Corp. 6359

Gas Survey Recorder—A gas survey recorder that cuts load research costs is the subject of a new 4-page *Catalog No. 35-1543* recently published. This catalog reviews the basis for scientific gas-demand studies, and describes how survey costs can be minimized.
Fischer & Porter Co. 6360

Dust Analysis—New 44-page publication, *Dust Topics*, is now available. The latest issue of this periodical describes new equipment for dust surveys, air-pollution analysis, radiation protection, and special submicron filtration apparatus. Complete specifications, operating characteristics, and prices are given for each item. Over 100 different instruments are described.
Gelman Instrument Co. 6361

(*Continued on p. 71*)

LITERATURE

(*Continued from p. 68*)

Autographic Plotters—A new brochure, *Bulletin PG-100*, on the line of multi-record autographic plotters is being offered. The bulletin contains application data and complete specifications on Gilmore standard, high-speed, and extra-high-speed strain gage plotters; modular plotter; and segmental recorder and scanner plotter.
Gilmore Industries, Inc. 6362

Stopwatch—A new 16-page stopwatch selection guide describing a complete line of precision timing instruments for all segments of industry, including production analysts, engineers, and other in design, testing, and control has been announced.
Heuer Timer Corp. 6363

Laboratory Catalog—The 16-page *La-Pine Apparatus Review 12* announces many new laboratory instruments such as spectrophotometers, pH meters, electrobalances, recorders, and related equipment.
Arthur S. LaPine & Co. 6364

Recorders—New 48-page Electronik Recorder *Catalog No. C 15-1a* highlights new modular design features, the quick-changing 2- to 24-point electronik universal multipoint recorder, and other electronik strip and circular chart recorders and precision indicators.
Minneapolis-Honeywell Regulator Co. 6365

Calcium Determination—New 2-page data sheet describes a continuous, automatic method for determining the presence of calcium down to parts per million at a rate of 20 analyses per hour. The analytical procedure is detailed. A flow diagram of the analytical system and actual chart recordings derived therefrom are included.
Technicon Controls, Inc. 6366

Inspection Lights—A bulletin describing and illustrating 12 types of inspection lights has been issued. Included are direct types for surface or interior inspection, prefocused lights, adjustable-focus lights, lights combined with magnifying lenses, lights with rotatable mirrors for right-angle vision in relatively large bores, and borescopes for right-angle vision in small bores.
Welch Allyn, Inc. 6367

LABORATORIES

Bjorksten Research Laboratories, Madison, Wisc. and Houston, Tex.—announce the extension of their laboratory services to include custom organic syntheses. They have recently installed, in a separate building at their Madison laboratories, reaction and still equipment of up to 30-gal capacity suitable for organic syntheses, polymerizations, etc.

The International Nickel Co., Inc., New York, N. Y.—A new technical service which will deal with nickel alloys at ele-

(*Continued on p. 72*)

LABORATORIES

(*Continued from p. 71*)

vated temperatures has been established in the Development and Research Division of the International Nickel Co., Inc., according to an announcement by F. L. LaQue, vice-president and manager of the division. This new High-Temperature Engineering Section will serve industry on all problems arising in the use of materials in environments at elevated temperatures. The new section will develop and disseminate technical information in the field of high temperatures and will also be prepared to give advice on the selection of appropriate materials for high-temperature applications.

Physics Research Laboratories, Hempstead, N. Y.—was founded in 1952 as a consulting service to several fields of applied physics and instrumentation. The increasing demand for greater precision of measurement and the verification of accuracies usually available only from the National Bureau of Standards caused PRL to open its laboratory facilities on a commercial basis. Thus, the industry now has available a primary standards electrical testing and calibration facility, using standards and basic measuring instruments traceable to the National Bureau of Standards.

MATERIALS

Lubricant—Extreme-pressure, antiscoring lubricant, a highly effective lube oil for extreme pressure in machine tool and other manufacturing processes, is available. Manufacturer claims that lubricant will withstand 20 tons pressure per square inch without breakdown.

Chicago Manufacturing & Distributing Co., Chicago 3, Ill.

Magnet Wire—A new high-temperature, abrasion-resistant magnet wire employing a cross-linked polymer for insulation has been announced. The new wire, called Hitemp FX, possesses unusual abrasion resistance, in addition to operating continuously at temperatures in excess of 260 C. Its tough yet thin insulation overcomes the problems of poor abrasion, cold flow, and resistance to impregnating and potting encountered in other high-temperature insulation.

Hitemp Wires Co., Div. of Simplex Wire and Cable Co., Westbury, N. Y.

Aluminum Porcelain Enamels—Porcelain-enameled aluminum is the subject of a new 6-page supplement to *Lead in the Ceramic Industries*, published by Lead Industries Assn. Containing information on the chemistry and properties of these lead-bearing enamels, the supplement is designed to give the potential producer of porcelain-enameled aluminum products information on what these enamels are and what they will do. Porcelain-enameled aluminum is a durable, scratch-resistant, colorfast finish that will not fade or lose its surface finish after long exposure to the weather or to constant cleaning with alkaline detergents. Remarkably, the glassy

(*Continued on p. 74*)

MATERIALS

(*Continued from p. 72*)

porcelain-enameled coating is no deterrent to cutting, sawing, shearing, or drilling of the metal.

Lead Industries Assn., New York, N. Y.

Single Crystals—The high-purity single crystals of refractory metals produced at the ultra-high-purity materials laboratory of Materials Research Corp. go out into the world equipped with a pedigree. On the data sheet accompanying each one there are full specifications: crystal orientation as determined by Laue X-ray techniques, dislocation count, hardness measurement, chemical analysis, production procedures, etc.

Materials Research Corp., Yonkers, N. Y.

Graphite and Carbon Felts—Nonwoven forms of flexible graphite and carbon are produced by the same process as graphite cloth. The diameter of the filaments in these products is about 0.0003 in. Insulation, gas filtration, and gasketing are some of the expected uses of these new, high-temperature, flexible materials. Oxidation in air is not a problem up to 650 to 700 F. In neutral and reducing atmospheres all these felts can be used at temperatures up to about 5000 F. The strength of graphite felts at 3000 F is about double that at room temperature. Electrical resistance of graphite felts decreases at 2500 F to about 50 per cent that of the room-temperature value. When compressed to a density of about 8 lb per cu ft, the thermal conductivity of grade WDE carbon felt is about 0.2 Btu ft per hr sq ft deg Fahr at room temperature. Comprehensive thermal conductivity data for all grades is being determined. At room temperature the specific heat of these felts is 0.16 Btu per lb deg Fahr, rising to 0.40 at 2700 F.

National Carbon Co., New York, N. Y.

Sonofin—A new textile softener known as Sonofin 3639A, which is said to be compatible with a wide variety of finishing agents, has been announced. Sonofin 3639A is a low-cost softener and lubricant recommended for use in textile wet processing. It is a monionic, white liquid which, according to Sonneborn, can be used with resins, catalysts, dye fixatives, and dyes. Sonofin 3639A emulsions are noteworthy for their uniformly fine particle size (less than 1 micron). The company recommends it for use in package dyeing machines, and further points out that knitting yarns treated with the new product are soft, resist shedding, and assure trouble-free knitting with better and consistently uniform stitch formation. The use of the product with wash-and-wear and crease-resistant resins on cotton and synthetic fabrics increases tear strength, abrasion resistance, and crease recovery. It lubricates and minimizes friction between the threads, resulting in improved wear, reduced needle cutting, and better sewability.

Sonneborn Chemical and Refining Corp., New York, N. Y.

NEW MEMBERS

The following 32 members were elected from November 10 to December 6, 1960, making the total membership 10,582 . . . Welcome to ASTM. Names are arranged alphabetically, company members first then individuals. Your ASTM Year Book shows the areas covered by the respective Districts.

Chicago District

Stubbings, Robert, director, Leather Inst., Milwaukee School of Engineering, Milwaukee, Wis.

Cleveland District

Hinsdale, C. M., chief specification writer, Schafer, Flynn & Williams, Cleveland 14, Ohio.

Mississippi Valley District

Cooper, William H., fire protection engineer, Military Air Transport Service, Scott Air Force Base, Ill.

Wilbur, Ralph C., manager, Refinery Laboratory, Shell Oil Co., Wood River, Ill.

New England District

Brennan, John Emmet, III, structural engineer, Perley F. Gilbert Associates, Architects, Lowell, Mass. [A]

Cholmar, Sidney, package engineer, Fome-Cor Corp., Springfield, Mass.

Peck, Robert D., president, Controlled Environment, Inc., Needham, Mass.

New York District

Arlin Chemicals, Inc., Leo Liberthson, technical director, Building Products Div., Carlstadt, N. J.

Elmer, Lloyd A., manager, New Products, General Devices, Inc., Princeton, N. J.

Siedenberg, Julius, chief chemist, Schwarz Laboratories, Inc., Mt. Vernon, N. Y.

Stack, Eugene A., metallurgical engineer, Reaction Motors, Division of Thiokol Chemical Corp., Denville, N. J.

Northern California District

Allen, Rex Whitaker, architect, San Francisco, Calif.

Bellah, Willard, laboratory technician, H. K. Porter Co., Inc., Pioneer Works, Pittsburg, Calif. [A]

Rainey, Edgar W., metallurgist, San Mateo, Calif.

Ohio Valley District

Kuhlmann, Henry W., project engineer, Battelle Memorial Inst., Columbus, Ohio.

Philadelphia District

Sarver, Clifford F., director of research, Imperial Type Metal Co., Philadelphia, Pa.

Van Gavree, R. L., manager, Engineering Dept., Reeves-Hoffman Div., Dynamics Corporation of America, Carlisle, Pa.

Pittsburgh District

Houze Glass Corp., Albert Lewis, manager, research and development, Point Marion, Pa.

Rocky Mountain District

Portland Cement Company of Utah, Edwin S. Gallacher, production manager, Salt Lake City, Utah.

Southeast District

Cook, E. Lewis, president and general manager, Industrial Metals Testing Co., Inc., Chattanooga, Tenn.

Nolan, George P., branch manager, Pittsburg Testing Laboratory, Nashville, Tenn.

Southern California District

United Earth Sciences, Division of United ElectroDynamics, Inc., T. Winston, project engineer, Pasadena, Calif.

Southwest District

Amis, Thomas L., executive vice-president and general manager, Wesco Materials Corp., Dallas, Tex.

DeManuelle, John P., chief chemist, Polymer Chemicals Div., W. R. Grace and Co., Baton Rouge, La.

Guevara, Eduardo A. J., president, Concrete Controls, Inc., New Orleans, La.

Thomas, Gray I., branch manager, The Master Builders Co., Cleveland, Ohio.

Washington, D. C., District

Stier, Howard L., director, Division of Statistics, National Canners Assn., Washington, D. C.

Western New York District

Pullerits, K., Raymond International Co., Ltd., Toronto, Ont., Canada.

Outside Established Districts

Nevada, University of, Library, Reno, Nev.

Other Than U. S. Possessions

Instituto Nacional de Tecnologia Industrial, Salvador M. del Carril, president, Buenos Aires, Argentina.

Kerr, W. David, director of research and development, pulp, Research Laboratories, Fraser Cos., Ltd., Atholville, N. B., Canada.

Reimer, D. V., production manager, Coast Steel Fabricators, Ltd., Lake-City Industrial Park, Burnaby, B. C., Canada.

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* [A] denotes Associate Member.

GOVERNMENT STANDARDS CHANGES

THE FEDERAL Supply Service of the General Services Administration is charged with the responsibility for establishing specifications to be used by the Federal Government for Procurement of materials and supplies. The GSA issues an annual Index of Initiation of Federal Specifications Projects, and monthly supplements.

The following items appeared in Supplement 8 for October, 1960

INITIATIONS

Title	Type of Action	Symbol or Number	FSC Class	Assigned Agency & Preparing Activity
Steel, Chemical Composition and Hardenability	Chg. Not. 2	Fed. Std. No. 66b	...	DOD-AFSSC
Aluminum Alloy Bars, Rods, and Wire, Rolled, Drawn, or Cold-Finished, 2024	Am. 1	QQ-A-268a	9525 & 9530	DOD-USAF
Artificial Leather, Cloth, Coated Vinyl Resin (Upholstery)	Am. 2	CCC-A-700b	8305	GSA-FSS
Belting, Conveyor, Rubber	Rev.	ZZ-B-206	3030	COM-NBS
Building Board, Asbestos-Cement, Corrugated	Rev.	SS-B-750b	5640	GSA-FSS
Cable, Power, Electrical (Rubber-Insulated, Building Type) and Wire, Electrical (Rubber-Insulated, Building Type)	Int. Am. 1	J-C-103b	6145	GSA-FSS
Carpet and Rug, Wool, Wool-Nylon, Loop Pile, Woven	Rev.	PD DDD-1-11a	8305	GSA-FSS
Cleaning Compound, Optical Lens	New	P-C-438	7930	DOD-Army-QM
Cloth, Cotton (Waffle Weave)	New	PD DDD-1-31	8305	GSA-FSS
Compress, Gauze	Rev.	DDD-C-570b	6510	VA-MS-DM&S
Copper Alloy Ingots, Leaded and Nonleaded Tin Bronze, Red Brass and Semi-red Brass	Rev.	QQ-C-525	9650	DOD-Navy-Ships
Creosote, Coal-Tar-Solution	New	TT-C-00650	6810	AGR-FS
Cushioning Material, Polystyrene, Expanded, Resilient and Flexible	New	PPP-C-00850	9330	GSA-FSS
Gasoline, Automotive	Rev.	VV-G-76a	9130	DOD-Army-Ord
Grease, Lubricating, Locomotive	Rev.	VV-G-679a	9150	DOD-Army-Ord
Insulation Block, Pipe Covering and Cement, Thermal, Calcium Silicate (for Temperatures up to 1200 F)	Int. Am. 1	HH-I-523a	5640	GSA-FSS
Lacquer, Cellulose Nitrate, Gloss	Rev.	TT-L-31c TT-L-0031b	8010	GSA-FSS

SPECIFICATIONS AND STANDARDS APPROVED FOR PRINTING

Title	Type of Action	Symbol or Number
Identification Marking of Copper and Copper-Base Alloy Mill Products	New	67a Fed. Std. No. 185
Metals, Test Methods	Chg. Not. 1	Fed. Test Method Std. No. 151a
Steel, Chemical Composition and Hardenability	Chg. Not. 1	Fed. Std. No. 66b
Adhesive, Urea-Resin-Type (Liquid and Powder)	Rev.	MMM-A-188b
Aluminum-Alloy Bar, Rod, and Wire (Free-Machining), 2011	Rev.	QQ-A-365c
Aluminum-Alloy Forgings, Heat Treated	Rev.	QQ-A-367e
Ammonium Chloride (Sal Ammoniac). Technical	Rev.	O-A-491c
Artificial Leather, Cloth, Coated, Vinyl Resin (Upholstery)	Am. 2	CCC-A-700b
Baking Soda (Sodium Bicarbonate)	Rev.	EE-B-86b
Cardboard and Railroad Board (Manila and Wood)	Rev.	UU-C-201e
Cleaning Solution, Porcelain	Rev.	P-C-450b
Cloth, Cotton, Broadcloth, Mercerized	Rev.	CCC-C-437b
Cloth, Cotton, Chambray	Am. 1	CCC-C-231c
Cloth, Nylon Bunting and Cloth, Nylon-and-Wool Bunting	Am. 1	CCC-C-476b
Conduit, Metal, Rigid (Electrical, Aluminum)	Rev.	WW-C-540a
Ethylene Glycol Monoethyl Ether, Technical	Rev.	TT-E-781b
Fiberboard, Insulating	Canc.	LLL-F-321b
Funnel, Filtering, Laboratory, Glass, Buchner Type	Rev.	DD-F-776c
Funnel, Filtering, Laboratory, Porcelain, Buchner Type	Rev.	DD-F-786c
Gold Leaf	New	QQ-G-547
Insulation Board, Thermal, and Insulation Block, Thermal	New	LLL-I-535
Magnesium Alloy, Sand Casting	Rev.	QQ-M-56b
Mattress, Bed, Latex Foam	Rev.	ZZ-M-91c
Molding Plastic, Methacrylate	Rev.	L-M-500a
Paint, Ready-Mixed, Outside, Medium-Chrome-Yellow	Rev.	TT-P-53c
Paper, Book	Rev.	UU-P-465d
Paper, Cover	New	UU-P-196a
Paper, Duplicating, Copy, Liquid Process	Rev.	UU-P-232b
Paper, Index	Rev.	UU-P-258f
Plywood, Flat-Panel	Rev.	NN-P-530a
Potassium Hydroxide, Technical	New	O-P-566
Steel Sheets, Carbon, Cold-Rolled	New	QQ-S-692b
Steel, Sheet, Carbon, Hot-Rolled	New	QQ-S-693b
Sweeping Compound Absorbent Material, Oil and Water	Am. 4	P-S-865a

CALENDAR

January 29–February 3—**American Institute of Electrical Engineers,** Winter General Meeting, Hotel Statler, New York, N. Y.

February 7–9—**Society of the Plastics Industry, Reinforced Plastics Div.,** Edgewater Beach Hotel, Chicago, Ill.

February 13–16—**American Society of Heating, Refrigerating and Air-Conditioning Engineers,** Semi-Annual Meeting and Exposition, Conrad Hilton Hotel, Chicago, Ill.

February 15–17—**American Institute of Electrical Engineers,** Institute of Radio Engineers, University of Pennsylvania; Solid-State Circuits Conference, Philadelphia, Pa.

February 20–23 — **American Concrete Inst.,** 57th Annual Convention, The Chase-Park Plaza Hotels, St. Louis, Mo.

February 20–23—**Technical Association of the Pulp and Paper Industry,** 46th Annual Meeting, Hotel Commodore, New York, N. Y.

February 26–March 1—**American Institute of Chemical Engineers,** National Meeting, Hotel Roosevelt, New Orleans, La.

February 26–March 2—**American Institute of Mining, Metallurgical, and Petroleum Engineers,** Annual Meeting, The Chase-Park Plaza Hotels, St. Louis, Mo.

February 27–March 1—**Association of Iron and Steel Engineers,** Western Meeting, Hotel Statler, Los Angeles

March 5–8—**American Road Builders' Assn.,** Chalfonte-Haddon Hall, Atlantic City, N. J.

March 7–9—**American Railway Engineering Assn.,** Annual Meeting, Conrad Hilton Hotel, Chicago, Ill.

March 11–14—**The Steel Founders' Society of America,** Annual Meeting, Drake Hotel, Chicago, Ill.

March 13–17—**National Association of Corrosion Engineers,** Annual Conference and Show, Statler Hotel, Buffalo, N. Y.

March 20–23—**Institute of Radio Engineers,** National Convention, New York, N. Y.

March 20–24—**American Society for Metals,** Western Metal Exposition and Congress, Pan-Pacific Auditorium, Los Angeles, Calif.

March 21–30—**American Chemical Society,** St. Louis, Mo.

BOOKSHELF

(*Continued from p. 53*)

The Nature and Properties of Engineering Materials

Zbigniew D. Jastrzebski; John Wiley and Sons, Inc., New York, N. Y. (1959); 371 pp.; Illus.; $11.

THIS BOOK was reviewed in the July issue of the ASTM BULLETIN under the title, *The Structure of Matter*. The correct title of the book is *The Nature and Properties of Engineering Materials*.

INDEX TO ADVERTISERS

GOVERNMENT STANDARDS CHANGES

(Continued from p. 76)

INTERIM FEDERAL SPECIFICATIONS ISSUED

Title	Type of Action	Symbol or Number
Cable, Power, Electrical (Rubber-Insulated, Building-Type) and Wire Electrical (Rubber-Insulated, Building Type) (GSA-FSS) (Rev. FS)	New	J-C-103b
Lacquer, Rubbing, Clear (for Wood Furniture) (GSA-FSS) (Rev. FS)	New	TT-L-0057a
Toluene (Toluol) (for Use in Organic Coatings) (GSA-FSS) (Rev. FS)	New	TT-T-00548b
Cloth; Coated (Table and Shelf) (GSA-FSS) (Am-1)	Am. 1	CCC-C-417a
Type Cleaner, Liquid, with Dauber (1,1,1-Trichloroethane) (GSA-FSS) (Am-1)	Am. 1	P-T-936b
Creosote, Coal-Tar-Solution (AGR-FSS) (Rev. FS)	New	TT-C-00650
Pipe, Drain and Sewer, Plastic (GSA-FSS)	New	WW-P-00380
Blanket, Bed Other than All-Wool (GSA-FSS) (Am-1)	Am. 1	DDD-5-421d
Carpet, Loop, and Rug, Loop (Wool Pile, Knitted) (GSA-FSS) (Am-1)	Am. 1	DDD-C-80a

PURCHASE DESCRIPTIONS ISSUED

Title	Type of Action	Number
Carpet and Rug, Nylon, High-Low Loop Pile, Tufted	New	DDD-1-25
Carpet and Rug, Nylon, High-Low Loop Pile, Woven, Velvet Type	New	DDD-1-29
Carpet and Rug, Wool, Level-Cut Pile, Tufted	New	DDD-1-26
Carpet and Rug, Wool, Level-Cut Pile, Woven	New	DDD-1-10a
Carpet and Rug, Wool, Multi-Level, Textured, Loop Pile, Brussels Type	New	DDD-1-27
Carpet and Rug, Wool, Random Tweed Loop Pile, Tufted	New	DDD-1-28
Carpet and Rug, Wool, Woven, High-Low Loop Pile, Textured	New	DDD-1-30

CANCELLATIONS

Title	Symbol or Number	Reason for Cancellation
Bags, Shipping, Cushioned	PPP-B-30	Superseded by PPP-S-30
Flannel, Cotton, Heavy (for Table Felts)	CCC-F-456a	Superseded by CCC-C-460
Paper, Chart (Lithographic-Finish)	UU-P-171b	Canceled
Paper, Map (Lithographic-Finish)	UU-P-381a	Canceled
Plastics, Cellulose Acetate Plastic Sheets	Int. Fed. Std. 0078	No need for item
Plastic Polystyrene Molding Material	Int. Fed. Std. 00113	No need for item